SCIENTIFIC AMERICAN SUPPLEMENT. No 972

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Scientific American Supplement, Vol. XXXVIII. No. 972.
Scientific American, established 1845.

NEW YORK, AUGUST 18, 1894.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

M. CASIMIR-PERIER, PRESIDENT OF FRANCE.

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We present herewith a portrait of the new President of the French republic, M. Casimir Perier, for which we are indebted to L'Illustration. M. Casimir-Perier was elected to the presidency on the first ballot on June 27, to succeed M. Sadi Carnot, who was assassinated by the Italian anarchist Cesario, at Lyons, June 24. The family of the President has been conspicuous in public life for four generations.

Jean Paul Pierre Casimir-Perier, the new President of France, was born at Paris on Nov. 8, 1847. He studied there, and received a degree at the Sorbonne in literature and history. During the French-Prussian war he belonged to the Mobiles d'Aube, the department his father had represented at the outset of his public career. The regiment was summoned to the capital, and for his personal bravery young Casimir-Perier was mentioned in the political dispatches, and decorated with the button of the Legion of Honor.

He was from October, 1871, until February, 1872, his father's secretary in the Ministry of the Interior. In order to open a political career for his son, the older Casimir-Perier resigned his position in 1874 and presented his son as a candidate to the electors of Nougent-sur-Seine. The young man, strong in that region through the influence of his family, was elected to the Chamber of Deputies by 1,907 out of the 2,017 votes cast.

Previous to this time he had devoted some attention to his father's mining interests, but had acquired no political experience beyond what his duties as his father's secretary had given him.

In the same year, 1874, he conducted an active political campaign in his department against M. Argence, the Bonapartist candidate, and in favor of Gen. Saussier, the Republican nominee. At the general elections in 1876 for the new Chamber of Deputies in the arrondissement of Nougent-sur-Seine he was a candidate, with a strong profession of Republican doctrines, and was elected by an overwhelming majority. He voted always with the majority formed by the Left Center and the Republican Left, which refused a vote of confidence to the Ministry of Broglie. The union between the two parties was brought about by the efforts of Casimir-Perier. At the elections which followed the dissolution of the Chamber, Casimir-Perier was returned with 6,515 votes, against the 3,400 obtained by the Bonapartist candidate.

During his first year in the Chamber of Deputies he had been appointed Under-Secretary in the Department of Public Instruction, of which M. Bardoeux was minister. He remained in this position until 1879. In 1879 he passed from the Left Center to the Republican Left, and in 1881 became identified with the Republican Union. In February, 1883, after having been again elected the year before, he resigned his seat when the Chamber passed the law excluding all members of former reigning families from public office, on the ground that it was impossible for him to reconcile his political sentiments with his family duty. This was an act which would not fail to make its impression on the French people, and in a short time he allowed himself to be persuaded to become a candidate again.

He was elected, and in October, 1883, became Under-Secretary of War in the Ferry Ministry. He had never before held a position of such importance, and when he resigned it as a protest against the agitation looking to the expulsion of the Orleans princes it aroused a temporary distrust in his loyalty to the republic, despite the fact that his political career had been conservatively Republican throughout.

Several years later the Royalists presumed on this action, and offered Casimir-Perier an exalted position in return for his allegiance to their party. But their proposal was indignantly rejected by him, with the answer that he would rather be a citizen in a republic than a duke in a kingdom.

In 1890 he became Vice President of the Chamber, and has been three times elected to that position. In November last he became Prime Minister, and, failing a vote of confidence several weeks later, his Ministry was overthrown, and the result is supposed to have been brought about by his own efforts to further his prospects as a candidate for the presidency.

Casimir-Perier's republicanism has often been questioned by his political opponents. This is a part of his speech, touching especially on his political creed, made in 1893, when he accepted the portfolio of foreign affairs:

"The government before you finds its duty traced by the recent expression of the will of the country. Never has France affirmed with more force her attachment to the republic, her aversion to a period of reaction, her respect for liberty of thought and conscience, and her faith in progress. Never has universal suffrage more clearly condemned the politics of abstract formulas, of unjust restrictions and arbitrary classifications, nor more energetically preserved, in the face of the theories of certain schools, the maintenance of order and the defense of the principles given to us by the French revolution—liberty and individual property."

The new President is a man of military bearing, graceful and polished manners, and the dignity which is so often characteristic of Frenchmen in high positions. His election will prove more popular than that of Dupuy would have been, for the spectacle of a man of such rearing and tastes, as the representative of the nation, would probably have pleased very few classes of the French people.

ON COLOR PHOTOGRAPHY.*

By J. Joly, M.A., D.Sc., F.R.S.

It is doubtful if much more can be made of monochromatic photography than has already been accomplished. Indeed, we have had almost too much of it. If we take up a copy of a cheap monthly, I think we may well ask ourselves if we are any the happier for those half-tone illustrations which are given in ever-increasing abundance to the reader by a generous editor, who can more cheaply cover a page with this uncertain kind of art than with a page of letterpress. In nine-tenths of the photographic efforts we meet with, we find no art whatever. For this reason, I believe, long years of black-and-white photography have been of doubtful benefit to the æsthetic culture of the public at large. It would be quite out of place to go into that question; my only object in alluding to it is that I think the advent of photography in nature's colors will have a great influence in changing all this. Any one who has looked on the exquisite image in his camera, full of light and color, will understand me; it is nature. Photography in monochrome is most generally neither nature nor art. We cannot have too much of nature. We cannot bring it often enough before our fellow beings. The mission of photography in the future will be to bring to the dwellers in our cities the glories of tropical vegetation; of seas and skies which their eyes can never directly behold. This is a great aim; it will most certainly be accomplished.

No method suggested in recent years of accomplishing photography in natural colors has at all been so fundamental in principle or so thorough in its aims as those we thought first successfully applied to colored photography by Lippmann. This method aims at reproducing the very wave-lengths with absolute accuracy of the original colors. It aims at this; but it is, at present, only with the greatest care that it can be made to accomplish it. Any one here who has worked at the method will, I think, bear me out in what I say. We can get iridescent gleams of purple, blue and green on the spectrum without very much trouble; but the greatest uncertainty appears to attend our results. Exposing under colored glasses again, I have found that the tints obtained resembled only approximately the originals. I was not so fortunate as to get exact similarity. Of course, all new methods are attended with difficulty, but there appear some differences in limitations to the applications and value of this method which, unfortunately, appear inherent to it. The first is, that the image is not transparent. In fact, this deficiency at once removes the method out of all competition with lantern-plate methods. It confines its application to wall pictures or album pictures. The second is, the picture is iridescent in its nature—it is a picture made of such gleams as we see in mother-of-pearl, beautiful in themselves, indeed, but not in keeping with the reproduction of the colors of objects possessing fixed color. This last is a grave deficiency. The album prints or wall pictures must be so mounted or set as always to be regarded from the one point of view only. We must look at them in that same direction in which the light fell upon them when they were being taken. Lastly, the colors depend upon a distribution of metal in the image which, subjected to the least alteration, destroys the fidelity of color; thus, moisture swelling the film, or any change within the film, must be guarded against. One thickness only of the film is absolutely correct—that obtaining when the image was being formed; and here we touch upon what is probably one source of trouble in obtaining good results from this method. The film we expose in the camera is charged with the sensitive salt throughout its entire thickness. The light waves streaming in from the image and back again from the reflector interfere with each other so as to produce stationary loops and nodes within the film. The positions of the loops are registered in invisible photogenic material. Now, when we develop, we build this photogenic material into metallic silver, and later we fix out all the intervening unacted upon bromide Can this be effected without changing the thickness of the original film? We must remember we are dealing with half waves by the distances. A fraction of a half wave length distance will at once shift the color. In fact, the entire range of the spectrum is about one octave. The effect of this will be that the perpendicular direction would cease to be the direction of accurate color reproduction, and we are left to choose the correct direction for ourselves.

And this brings me to recall a fact of history which the photographic world does not appear at all sufficiently alive to. I allude to the debt of gratitude we owe to the German physicist, Wiener, in this matter of color photography by stationary waves. In the year 1889, before the convention of German naturalists and physicians, Otto Weiner read a paper—now classical—on Stationary Light Waves and the Direction of Vibration of Polarized Light.

This paper appeared in Wiedemann's *Annalen* for May, 1890. In this paper he considers if it might not be possible to demonstrate stationary light waves in a photographic film in a manner analogous to Kundt's method of demonstrating stationary sound waves by light mobile powders. He discusses the conditions under which this might be done. The film must be of extreme thinness and transparency. Such stationary waves, he points out, were suggested by Zentier in 1868 as affording an explanation of the color in the chloride of silver photographs of the earlier workers. "The solution of this question," he adds, "would be of the greatest interest, and, above all, that of how far stationary waves may be utilized in the problem of procuring photographs in natural colors." But not only did Wiener thus suggest the application of stationary waves, and define the conditions under which they might be caused to act in a photographic film, but he, as many here know, in this same paper, actually accomplished the photographic registration of such stationary waves in a silver chloride collodion film. He employed reflection from a polished plate of silver deposited on glass, using this to back the collodion film. This, however, was only on his way to dealing with an important physical question, and the solution of this question led him away from carrying out his own suggestion of applying these stationary waves to color photography. It is quite too soon for us all to begin to forget Wiener and his work. The exquisite suggestion was almost entirely his, and the pioneer's work was his, and, as we ourselves may some day hope to have our own priority for this and that respected, let us respect his.

We must even, if we wish to be quite just, go back further, and recall that Hertz's work was the foundation of the whole matter. Wiener freely acknowledges how Hertz's gigantic stationary light waves stimulated him to resume an old research upon waves of visible light. He was only working at one end of a spectrum, Hertz at the other; a very long spectrum indeed it would be if all the intervening wave lengths were filled in. Wiener finds his loops by the aid of unstable molecular groups; Hertz walked about among his loops, and detects them by a resonating circuit fifteen or twenty inches in diameter. To point any moral upon this origin of practical results in investigation is needless here; to the general public it is but continuing that perpetual crying in the wilderness.

I must now briefly turn to the other method of color photography at present before the public—that is, composite color photography. It will not be out of place to run over its essential features, for many are very excusably uncertain yet as to its rather involved principles. I fear to be historical, for the method has been led up to by so many workers.

There is good reason to believe that, in the case of normal vision, the nerves in our eyes are separately only capable of transmitting three distinct sorts of color sensation—a red, a green and a blue violet sensation. It is surmised that all other sensations of color are due to the simultaneous excitation of two or three nerve systems to different proportionate degrees. Thus, when we look at the orange in the spectrum, we experience an orange color sensation solely because our red sensitive nerves and our green sensitive nerves are both stimulated to different degrees. Further up the spectrum, on the shorter wave lengths, our blue sensitive nerves aid in producing the various compound sensations which constitute the infinite gradation of tone extending up into violet. Most people find it difficult to grasp that a red sensation is excited at a part of the spectrum which looks greenish blue, for example. But there is everything to bear out the theory that the only reason why we do not *feel* the red sensation *as* a red sensation is because the green and blue sensitive nerves are also active, and we cannot analyze the compound sensation transmitted to the brain.

Now I put on the screen a photograph of three curves drawn above the supposed length of a spectrum. The curves are those obtained by Konig. The curve with red written upon it represents the varying degree of red stimulation which our red sensitive nerves experience by the different wave lengths of the spectrum. Thus, suppose I could remove the blue and green nerve systems, or deaden their action, and leave the red nerves alone active, then the brightness of the spectrum to my red sensitive eye would vary along its length proportionately to the height of the red curve. Thus you see it would look very bright somewhere near the D line, and would look much darker all through the blue; and finally, in the violet it would die out in into complete darkness, and we would be as unconscious of the existence of the extreme violet waves as we are at present, when, with our normal eyes, we look at the ultra-violet region or at the ultra-red. Without delaying further, it is sufficient to remember that the green curve simply represents the brightness of the spectrum to the red-blue blind person, and, finally, the violet curve the brightness to the red-green blind person. Consider, now, what happens to the normal vision, possessed of the three nerves, when regarding a point in the green-blue, for example. The red nerves are stimulated to a degree represented by the vertical line above the base line of the red curve, the green nerves by the ordinate to the green curve, the blue by the ordinate to the blue curve.

Suppose, now, we wished to photograph the spectrum. We obtain three distinct photographs of the spectrum, and thus get three negatives. But these negatives are not alike. In fact, we interpose before one of them such light absorbing materials as will cause the image of the spectrum to be densest about the D line and to show gradual decreasing density into the violet on one side, into the ruby-red in the other. We may speak of such a plate as *stimulated to opacity* by the various parts of the spectrum in the same manner as our red sensitive nerves are stimulated to redness as they are exposed to the various wave lengths Where we see the red lightest the plate is densest and so on. Our second plate is taken through absorbing materials which allow the plate to be stimulated to opacity in the same manner as our green sensitive nerves are stimulated to greenness by the various wave lengths, and so also the third plate records in depth of silver deposit the degree of stimulation which our blue sensitive nerves experience along the spectrum.

Now we take positives of three plates, and evidently we may speak of these positives as severally *stimulated to transparency* as our nerves are stimulated to redness, greenness and blueness. How are we to use these positives? We put a piece of red glass behind the red transparent plate, green glass behind the green transparent plate, and blue glass behind the blue transparent plate. We project all three upon the screen correctly, adjusting the images in their proper positions and we have again the spectrum in all its variety of tones.

To again consider the former example, the tones are the green-blue. This, upon the screen, is built up of red, green and blue light. The transparency of each lantern plate at the point is, moreover, exactly proportional to the several degrees of stimulation experienced by our red, green and blue nerves at this point when viewing the spectrum. Hence, the synthesized image at the point carries the same sensation as the original did and we see the composite color of the original.

Of course, as every wave length in the colors of natural objects is represented in the spectrum, all the color sensations excited in us by natural objects can be synthesized by the method of triple image photography. It is not in my opinion fair to say that this method is not really photography in natural colors, for this implies more than is meant by those who say it. The most that can be said on this score is that the method of taking the plate and viewing the picture is not the same as the ideal color photography. But the colors are natural colors, both theoretically and, as has been shown, practically too.

Here, however, I must observe that some latitude appears to be allowable in taking the several negatives. In experiments of my own I have found this to be the case, and it is remarkable that Ives' earlier results were obtained according to an erroneous color

* Read before the Photographic Convention, Dublin, July, 1894.

curve. Indeed, this was just the point upon which Mr. Ives had deemed Stolze to be in error. Nor is the variance an inconsiderable one. The question at issue was whether the fundamental red sensation is excited by the wave lengths in the blue-green and those beyond, and similarly whether the violet sensation is excited only by green-blue violet rays. Now, it appears very certain—as appears from the reasons given by Abney—that the red and violet sensations are not confined to opposite ends of the spectrum. If this were so, a green blind person would see two spectra separated by a region of darkness, where both violet and red just failed to excite vision in him. As a fact, he sees what to him is white light, due evidently to compound blue and red sensations. The curve of Konig's measurements, which we have upon the screen, also supports this view. Now, Ives worked upon Maxwell's curves which you see before you, and in spite of the great discrepancy, obtained excellent results. From this, and from some experiments of my own, it does not appear to me as if very accurate reproduction of the curves was requisite in the practice of this method. This is fortunate, for to get the correct densities is a matter of much difficulty.

The great charm of this method is that it allows of optical projection. The colors are pigment color. Again, the registering positives can be freely copied.

And here I must break off. I have only ventured to say what I thought might be useful in enabling those present who have given less time than I have to color photography to follow the remarks of members of the convention far more experienced in those methods than I am.

It had been my hope that I would have been able to lay before you some results obtained by a procedure of my own, which I had been working at in the spring of last year. I had put this aside, thinking the difficulties greater than they actually proved to be, when I set about preparing to bring the matter before the convention. The inexpediency of bringing a publication before patents are completed has debarred me from seeking your criticism as I would have wished to have done. It must be my hope that at a future assembling of this convention I may be allowed to submit my work to your judgment.

Dr. Joly then exhibited and described

THE PHOTOGRAPHIC SEXTANT.

If it is not too much to expect that navigators should know how to develop a negative, in these days of reliable plates and ready mixed developers, the snap shot camera may be made of real value in the determination of solar altitude at sea. Not only might the accuracy of observation be greatly increased, but the risk of a false reading reduced to a minimum. What is perhaps of more importance, a moment too brief to afford a reliable eye observation might be completely availed of by the use of a photographic sextant. Lastly, and of not least importance, a permanent record of the observation remains for reference subsequently in case it be called in question.

The photographic sextant is not, in its optical principles, different from Newton's sextant (or, as it is called, the Hadley's sextant); that is, the fundamental principle is retained, viz., that the angle between the first and last directions of a ray which has undergone two reflections in the same plane is equal to twice the inclination of the reflecting surfaces to each other. There is, as in the ordinary sextant, a movable limb carrying a vernier, which travels over a divided half quadrant. This limb carries also a mirror at its axis of rotation in the usual manner, reflecting the image of the sun on to a second fixed half silvered mirror. This last mirror is situated at a little distance in front of a lens, which forms an image of the twice reflected solar disk as well as an image of the distant horizon which the lens commands through the clear half of the fixed mirror. In fact, the camera takes the place of the telescope or the ordinary sextant.

To enable the observer to point the instrument, matters are so arranged that the image formed by the lens is, before exposure, reflected out by a movable mirror forming part of the shutter, and inclined at 45° to the axis of the camera. This image is again reflected by a second mirror, and the image of sun and horizon either directly brought to the eye of the observer by the intervention of an eyepiece, or cast upon a small screen in the manner of some viewfinders. The mode of using the sextant is as follows: As the observer will know most generally his position, within certain small limits, he conveniently sets the vernier of the limb to read a whole number of degrees near the reading expected. He is now ready to take his snap-shot when any opportunity offers; if the sky be clouded, simply sighting the sun through the viewfinder, and noting the time immediately upon releasing the shutter. The position of the sun in reference to the horizon, measured upon the negative, will now give him, in conjunction with the reading to which the limb is set, and when corrected for dip and refraction in the usual manner, the altitude of the sun observed. If he knows the local time, he has all the data required for calculating latitude. If he does not know the local time, a second snap-shot will be requisite; or he may make one at, or very close to, the hour of noon, the last two methods being most generally useful.

In computing the angular separation of the sun and horizon by measurements upon the negative, it is requisite, of course, to know the constant of the instrument he is using. This may be found by photographing, at a known distance, a linear measurement of known dimensions. I may remind the reader that astronomers, measuring upon photographic plates, can estimate the separation of stellar images to the one-sixtieth part of a second.

To prevent solarization, dark glasses are used in the usual manner. These will not, of course, interfere with the light coming from the sky line.

The negative may be preserved for future reference. It must be labeled with the fixed reading of the limb and the time and date of observation. This is all that is required to render it an absolutely permanent record, or it would not be difficult to contrive that the setting of the limb be photographically recorded upon the plate when taking the snap-shot.

To render the construction of the instrument more clear to you, I have had the wooden model constructed which is upon the table. It was hardly accurate enough to serve to determine the latitude of Dublin, but a photograph of sun and horizon taken by it may be of interest.

RECENT PROGRESS IN ASTRONOMICAL PHOTOGRAPHY.*

By Mr. A. TAYLOR, F.R.A.S.

ASTRONOMICAL photography has been dealt with before the convention on two previous occasions; by the late Father Perry, at Birmingham, and by myself at Bath. To-night I desire to give an account of some of the new methods of work, and the results which have been obtained during the last three or four years—in fact, since the meeting of the convention at Bath. It will be well, perhaps, that I should first call your attention to the remarkable way in which the introduction of photography to astronomy has not only opened out new and unexpected fields of research, but has necessitated an entire revolution in the instrumental equipment of the modern observatory. As our president recently pointed out in a discourse to the Royal Institution, it was necessary to entirely rebuild the telescope in order to fit it for photography. In visual observations irregularities in the movements of the telescope were comparatively unimportant, so easy was it for the observer to correct them as they occurred, and to suspend his measurements until the celestial objects he was measuring were accurately placed on the cross wires of his micrometer. In a photograph, however, the record is not that of any selected moment, but is an accumulation of impressions made throughout the whole of the exposure; and any irregularities of movement of the instrument would cause the star images to appear as lines, instead of round dots. A general strengthening of the instrument was, therefore, the first necessity, and the stand, moving parts and tube are much stronger in modern than in the old instruments. A much greater accuracy of movement being required, special attention had to be paid to the bearings, and the driving arrangements were considerably improved. In an instrument like that made by Sir Howard Grubb for Dr. Gill, at the Cape, a photograph of which I now show you, special attention has been paid to all these points; and the new electrical control (from an invariable pendulum), invented by Sir Howard, so regulates the movement that it is impossible for the error of the pointing of the telescope to amount to more than one-fortieth of a second of time during the whole exposure given. As some exposures have extended to twelve hours, given in three successive periods of four hours each on successive days, and the resulting photographs have shown perfectly round star images, I think there can be little doubt that the required delicacy and accuracy have been completely attained.

Eighteen of the principal observatories of the world are co-operating to produce an international photographic catalogue and a photographic chart of the stars, using object glasses of 13 inches aperture and 11 feet 3 inches focus. No less than 22,000 plates are required for each series, the catalogue plates, with five minutes' exposure each, giving all stars to the eleventh magnitude, while the chart plates, with forty-five minutes, will include all stars to the fourteenth magnitude. The samples of these I show you are from negatives by Dr. Gill, at the Cape.

In the study of the details of nebulæ much valuable work has recently been done, but none are so remarkable as those of Dr. Gill with the nebula near η Argus. Here, with three hours twelve minutes' exposure, you will see the remarkable character of this object; but the next slides, which show Herschel's drawing of the nebula, and a photograph taken with twelve hours' exposure at the Cape, are still more striking. This S-shaped structure in the drawing is entirely absent in the photograph, and there is considerable doubt as to whether this is a case of real change in the nebula or inaccuracy in the drawing. It will give some idea of the number of stars shown by this photograph to mention that the space of sky that would be covered by a shilling held at arm's length from the eye contains 200,000 stars, scarcely one of which would be visible to the unaided eye.

With star clusters equally good results have been obtained. In the cluster ω Centauri a field glass will not show any individual stars. Gould's catalogue of southern stars gives seven as reaching the tenth magnitude, while this photograph with two hours' exposure gives no less than 6,389 stars.

Very much valuable work has been done with ordinary portrait lenses mounted on equatorial telescopes. The whole of the Milky Way in the Northern hemisphere has been photographed by Professor Barnard, at the Lick Observatory, and by Dr. Max Wolf, at Heidelberg; while Mr. Russell, at Sydney, has used his portrait lens for the same work in the Southern hemisphere. We have thus a complete photographic picture of the Milky Way, and the study of star distribution as shown on these photographs is yielding extremely valuable results. You will notice the bright cloud-like distribution of stars on these photographs by Professor Barnard, and the extraordinary dark lanes edged by bright stars that are characteristic of all these pictures, great similarity of which to the curves and other structures found in the solar corona are strong presumptive evidence of the existence of streams of dark matter ejected into a resisting medium in space. The connection between nebulous matter and stars shown by Dr. Max Wolf's photograph of the α Cygni region have a very important bearing on the question of the method of formation of stars; and, without entering into any technical discussion of these phenomena, I may say that many theories previously held will have to be abandoned, as a consequence of the new light thrown by photography on star distribution. As incidents in this photographic work, I will also point out meteor trails, such as are shown on this photograph of Dr. Wolf, and the discovery of minor planets, which is now almost entirely effected by the use of portrait lenses. Mr. Russell has turned his lens to the study of the dark patches in the Milky Way, and he shows that the dark rifts, and even the well known "Coal Sack," which was hitherto supposed to be quite devoid of stars, are really full of faint stellar forms. So far as we have gone at present in astronomical photography, we have not yet sounded the depths of the stellar universe; every increase of exposure has given a corresponding increase in the number of stars, and many eminent authorities believe that, with sufficient exposure, we shall find that the whole of the heavens is full of stars, and it will be possible to get plates in which the star images will be so numerous and so close together that they will overlap, and the plate will appear simply a blaze of light.

Turning to the spectroscopic work, we find that photography has almost entirely replaced visual observations. Professor Pickering, at Harvard, developed Fraunhofer's original design of the spectroscope, and showed the possibilities of the object glass prism in the study of stellar spectra. As an object glass will photograph a large number of stars in one field, it follows of necessity that, if we place a prism in front of and completely covering that object glass, we can simultaneously photograph, on the same plate, the spectra of all the stars in that field. Using this method, he has made a complete spectroscopic survey of all the stars visible from Harvard, and has extended the work by the establishment of observatories in Peru, so as to include all the southern stars. We thus have for the first time a complete spectroscopic catalogue of the stars; and the various stages of evolution from a cool to the hottest stage, and the regular cooling down to extinction, are readily recognized. This work has been further extended by Professor Lockyer at South Kensington, and I am able, by his kindness, to show you some of these photographs, in which you will see that the number of lines found in some stellar spectra will favorably compare with the number shown on our best solar spectrum obtained some years ago.

Dr. Vogel, of Potsdam, has adapted photography to the spectroscopic study of the motion of stars in the line of sight. Just as the steam whistle of an approaching train sounds shriller than that of a stationary one, while the whistle of a receding train is lower in pitch, so the wave length of the light of an approaching star is shortened, and that of a receding star is lengthened. It follows, therefore, that a photograph of the spectrum of an approaching star will have its lines displaced toward the blue, and that of a receding star will be displaced toward the red; and we can measure the amount of the displacement by photographing on the same plate a line from the spectrum of a terrestrial element for comparison. These photographs of the spectrum of α Aurigæ taken by Dr. Vogel at six months' interval show this displacement, and it is possible to measure, not only the rate of movement of the star itself in the line of sight, but also in this way to measure the rate of movement of the earth in its orbit round the sun. Photography is peculiarly fitted to this work, since it is quite independent of atmospheric irregularities, and the results obtained are far more accordant and accurate than any visual observations could possibly be.

A new kind of binary star has also been discovered by this photographic spectroscopic work. Some stars, photographed by Professor Pickering, in America, and by Dr. Vogel, in Germany, showed a periodic doubling of the lines, and this was clearly due to the fact that in these cases we were dealing, not with single stars, but with two stars which were revolving round a common center of gravity, the spectra of these being exactly superposed when they were moving at right angles to the line of sight, while, when moving in opposite directions, one spectrum was displaced toward the red and the other toward the blue. By measuring the amount of this displacement as shown on the photographs it is possible to determine the rate of revolution of each component; combining this with the period of revolution, it is possible to determine their distance from each other and the dimensions of their orbits, and also to calculate their combined and relative masses. The photographs of β Aurigæ, taken on successive days, show this doubling, and from a detailed examination of many plates it has been determined that the period of revolution is four days, the rate of movement 150 miles per second, their distance from each other 8,000,000 miles, and their combined mass 2·3 times that of the sun. No telescope that we can hope to construct will show this star as a double, and yet we have indubitable proof that it is one.

Time will not allow me to deal at all fully with the new star which was discovered in the constellation Aurigæ in February, 1892, but some points connected with it so clearly demonstrate the value of photography to the astronomer that I must briefly mention them. It was discovered visually on February 1, 1892, but previous to this the camera had secured many records. Professor Pickering has invented an automatic apparatus for photographing the whole of the heavens visible at Harvard on every clear night. This automatic camera had picked up this new star on December 10, 1891, and a photograph of the same region taken by Dr. Max Wolf on December 8 does not show it; its time of appearance is therefore fixed by photography to within forty-eight hours, and many valuable records of its varying magnitude were secured between the time of its photographic first appearance and its visual discovery. Unfortunately, the great and rapid accumulation of plates at a modern photographic observatory does not allow their very rapid examination, and the appearance of the Nova remained unknown until the visual discovery by Mr. Anderson, of Edinburgh.

The most recent work in solar photographic spectroscopy is due to Professor Hale, of Chicago, with his new instrument, the spectro-heliograph. This instrument, as you will see, differs very slightly in appearance from an ordinary spectroscope, the essential difference being that, instead of allowing the whole spectrum to fall on the photographic plate, Professor Hale arranges for the spectrum to be stopped by a metallic plate with a fine slit in it, which only allows monochromatic light to reach the sensitive surface. He then moves his spectroscope slit across the image of the sun, and, keeping his photographic plate fixed, the selecting slit moves at the same rate in front of the plate. When the instrument is arranged so that only the bright line, K, of the solar spectrum reaches his plate, he is able to photograph the solar prominences round the edge of the sun and the solar faculæ on the disk. A visual examination of the prominences would require at least two hours; the photographs can be obtained in as many minutes. Many faculæ, quite unobtainable by other means, are photographed by his instrument, and the results of the last two years' work have entirely revolutionized the study of solar physics.

* Read before the Photographic Convention, Dublin, July, 1894.

The beautiful character of his spectro-heliograms is sufficiently evident from the slides which his kindness enables me to show you.

At the total solar eclipse of 1893, April 15 and 16, the method of work was entirely photographic, and the results are far more important than any previously obtained. Time will not allow any discussion of these photographic results, but I thought you would be interested in seeing them, and I would particularly call your attention to the slide showing Bailey's beads, in which the solar corona is shown, and the edge of the sun breaking out at the end of totality. I have included the spectroscopic work in the slides brought down to-night.

STEAMER FOR PRESSED HAY.

IN Fyfe's system here illustrated the object is to compress the uncut hay as tightly as possible into bales, with the object of retaining heat (for drying it more effectually, and then submitting it to a steam pressure of 60 lb. to 80 lb. Loose or exhaust steam would be useless, as it could not possibly permeate a hard pressed bale; any such attempt would be merely cooking the outside while leaving the inside. The apparatus shown consists of a strong steel cylinder, 6 ft. long by 4 ft. diameter, mounted on four wheels, and with a removable cover at one end for the introduction of the material to be cooked. The other end of the cylinder is cambered, and carries a Westinghouse combined vacuum pump and air compressor, supplied with high pressure steam. The cover, which is slung from the arm shown when not in use, is provided with substantial steel lugs which engage with hinged bolts secured to the cylinder, and the rim is faced up to form an air-tight joint with the cylinder when the material is placed inside. Inside the cylinder is provided a heating coil and a floor plate. By means of suitable valves and pipes the pump may be employed to create a vacuum in the cylinder, after which steam is admitted, then blown off, and the vacuum pump is again brought into action to exhaust the remaining steam. The process is described by the Engineer as follows: The hay being closely pressed into bales to a density of 30 lb. per cubic foot, is now packed inside the cylinder, and the door being closed, the pump connected with the cylinder is set going to produce a vacuum. Steam under high pressure is then admitted and allowed to permeate the hay for fifteen to thirty minutes' duration, when it is blown off, and what remains is exhausted by means of the vacuum pump. For ordinary requirements the cylinders are made 20 ft. long by 6 ft. diameter, and are capable of holding from $2\frac{1}{2}$ to 3 tons of compressed baled hay at each operation. In dealing with wet hay under Fyfe's system, hot air under pressure and at temperature of 300° may be used instead of high pressure steam. One hour is said to be the time required to put hay through the entire process; fifteen minutes are required to fill the cylinder with hay and affix the door, while another fifteen minutes suffice to produce a vacuum and to get steam up to 80 lb. pressure. The cooking requires twenty minutes longer, a further ten minutes are needed to exhaust the steam, the bales are then ready to be turned out in a finished state. Besides possessing the advantage of great economy as regards fuel consumption and labor, this process, it is said, renders feasible the use of new hay for feeding cattle. Moreover, the hay being supplied in the form of bales, a railway truck is capable of holding more than twice as much as in the old truss form, thereby reducing proportionately the cost of transit. With the chemical features of this new process we shall not pretend to deal; but we may state that the result of analyses made by Mr. J. Barker Smith, L.R.C.P., Lond., upon different qualities of hay—treated and untreated—serve to show that the indigestible wood fiber is diminished, while the digestible fiber and carbohydrates are increased.

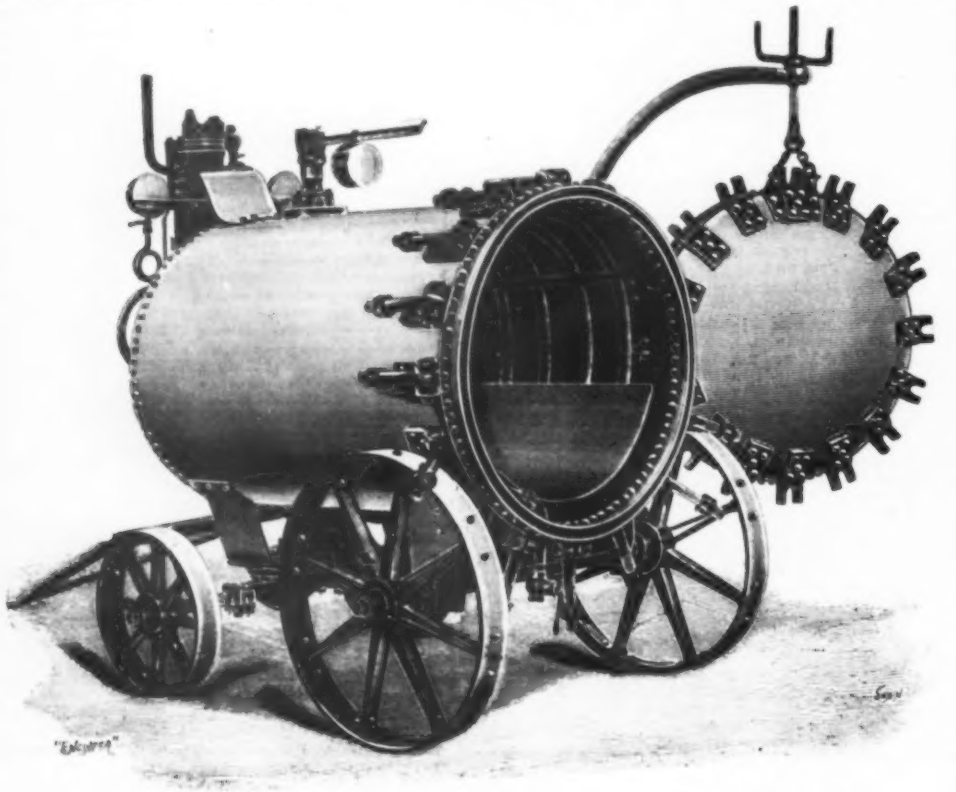


FIG. 1.—COVER REMOVED, SHOWING INTERIOR AND STEAM COILS.

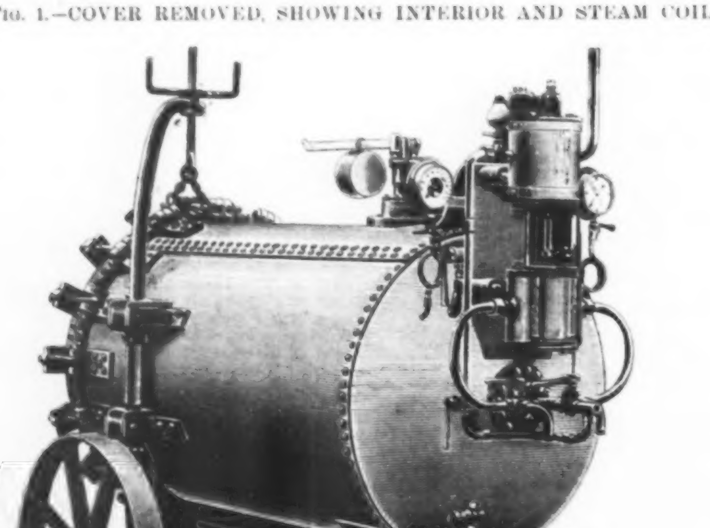


FIG. 2.—FRONT END, SHOWING AIR COMPRESSOR.

APPARATUS FOR STEAMING PRESSED HAY

THE MANUFACTURE OF SMOKELESS POWDER.*

By OSCAR GUTTMANN, Assoc. M. Inst. C.E., F.I.C.

THE general interest created by the appearance of the so-called smokeless powders for military use, and their adoption by nearly every army in the world, together with the comparative ignorance in which the civilian public finds itself with regard to the nature and production of these powders, made me think that a brief summary of the most striking peculiarities of this rapidly increasing industry would be of interest.

Most of you will be aware that in 1888 the world was first startled by the appearance of newspaper reports about a new and smokeless powder invented by a chemist of the French government, and that very soon after this the German army had a similar one. It has since been stated that the first experiments in connection with the discovery of smokeless powders were made in 1884, by Mr. Vieille, the well known chemist of the French government gunpowder factories. What this powder at that stage was is not quite clear, but it is not improbable that it consisted of a mixture of collodion cotton and picric acid, similar to the original basis for the much talked of Melinite. This composition, however, seems to have been abandoned after a short period, and that kind of smokeless powder which is now very largely used in other countries as well as in France to have been adopted.

In 1889, Alfred Nobel took out a patent for the manufacture of "Ballistite," which is an ingenious modification of his blasting gelatine. This and the above mentioned French powder are the two types upon which most of modern smokeless powders are based.

The first approach to a powder giving no smoke on combustion, and which at the same time was not composed of the usual saltpeter, sulphur, and charcoal mixture, was, apart from the guncotton used over thirty years ago, the Schultze powder, which has been used as a sporting powder in this country for more than twenty years, and which consisted of nitrated wood, prepared by the treatment of wood with nitric acid, mixed with saltpeter or a similar substance. Although this powder has been brought to great perfection for sporting purposes, it has failed to be practicable for military use, since it can hardly be such a uniform material as is required for this purpose.

A much nearer approach to the modern smokeless powders, and, in fact, in some way indicative of them, was the E.C. powder, invented by Mr. Walter F. Reid, and patented in 1882 by Messrs. Reid & Johnson. Generally speaking, Reid formed grains of nitrocellulose by putting powdered nitrocotton into a barrel, sprinkling it over with water and revolving the barrel, whereby, through agglomeration, grains of various sizes were formed. These were dried and then moistened with ether-alcohol, which had the effect of gelatinizing the surface of the grains. A small addition of aurine gave the powder an orange color. After being again dried, the grains were then put through a sieve in order to separate them, since they adhered slightly to each other through the gelatinizing process.

In a similar way Max. Von Forster made cubical guncotton powder by cutting cubes out of compressed guncotton, and dipping them into a solution of acetic ether, which coated them externally with a thin skin of collodion. This was only used for filling shells. Later on Messrs. Judson and Borland made a smokeless powder called the J.B. powder, by a process similar to the E.C. powder process, the only difference being that the guncotton grains were treated with a solution of camphor in benzoline, which, on being evaporated, left some camphor behind. This powder did not remain long in the market.

It is a pity that Mr. Reid stopped at this stage of the manufacture, because he was very near making that class of smokeless powders which are now known as pure guncotton powders; but in extenuation it may be said that at that time the want of such a powder had not been clearly expressed, since there was then neither rifle nor projectile in existence which would have been suitable for the use of powders whose pressures and velocities are so much higher than those of the ordinary black powder.

It is due to the success of the long continued experiments of two Swiss experts, Major Rubin and Professor Hebler, who have advocated for more than ten years the adoption of the small caliber rifle, that powder manufacturers have been forced to find powders suitable for the use of such weapons.

I remember very well how in the beginning of 1886, Professor Hebler showed me an experimental cartridge case made for his small caliber rifle, and asked me whether I could give him a pellet of compressed guncotton which could be loaded into such a cartridge case, and which would be likely to give to his long cylindrical projectile the required velocity. I then pointed out to him that such a charge would be impossible, on account of the sudden combustion and the very high pressure it would develop, and I offered to make him a small piece of blasting gelatine which would burn more in layers, and, therefore, probably suit his purpose better. The very suggestion of using blasting gelatine in a rifle was so much against all recognized ideas, that the matter was not further proceeded with; but after all, that rather hazardous suggestion of mine has turned out to be an idea in the

* Read before the London section of the Society of Chemical Industry, May 21, 1894.—From the Journal.

right direction, although I had no further part in its development.

Modern smokeless powders can be divided into three classes. First, those in which only guncotton is used, whether it be the so-called insoluble or the so-called soluble variety. Secondly, those in which nitroglycerine is used in connection with soluble or insoluble nitrocellulose. Thirdly, those which contain nitrocellulose in connection with a nitro-derivative of some aromatic hydrocarbon.

There have also been devised some other smokeless powders containing nitrocellulose in connection with oxygen carriers and also some which consist of merely mechanical mixtures of oxygen carriers and carbonaceous matters, but none of them have yet found favor for service use.

I will just briefly indicate the composition of those smokeless powders which have hitherto been devised. In the first place come the pure nitrocellulose powders, where the nitrocellulose is simply dissolved in some solvent and then made into flakes or grains. Such powders are the French B. powders, the German smokeless powder, the Wetteren, the Walsrode, Von Forster's, and various others. The French government, Von Forster and a few others are using a mixture of ether and alcohol as a solvent; the German factories, aceton. The nitrocellulose used is, as a rule, guncotton, although in some cases, wood nitrocellulose has been tried.

With the pure nitrocellulose powders can be classed the E.C. and the J.B. powders. The E.C. powder, now sold as No. 2, contains some camphor and is soaked throughout in ether-alcohol, whereby a harder grain results. To the second class belong powders made of nitroglycerine and nitrocellulose. There is first of all the Ballistite of Mr. Alfred Nobel, consisting of equal parts of nitroglycerine and collodion cotton, with an addition of 1 to 2 per cent. of aniline or diphenylamine. This Ballistite has, with some modifications, been adopted in Italy, Austria, and for some guns in Germany. In Italy, when made into cords, it is called Filite. To the same class belongs the Cordite adopted by the British government. This consists of 58 parts of nitroglycerin, 37 parts of the highest nitrated guncotton, and 5 parts of vaseline, which ingredients are dissolved in 19·2 parts of aceton.

Curtis and Andre made a powder consisting of 44 parts of trinitrocellulose, 12 parts of dinitrocellulose, and 40 parts of nitroglycerine, with an addition of solid paraffin and shellac solution, which is formed into grains by means of a mixture of ether alcohol. This powder is sold under the name of Amberite.

M. E. Leonard, of Manchester, in the United States, makes a powder of 150 parts of nitroglycerine, 50 parts of guncotton, 10 parts of lycopodium, and 4 parts of powdered urea crystals dissolved in aceton.

To the third class, namely, those containing nitrated aromatic hydrocarbons, belong the following powders: The Indurite of Professor Charles Munroe, which is made from insoluble nitrocellulose and nitrobenzin. The Dupont powder of the Dupont Powder Company, at Wilmington, U. S. A., which also consists of nitrocellulose and nitrobenzin granulated by a peculiar process.

There are also a large number of powders brought out by the Smokeless Powder Company, of Warwick, under the name of Rifleite, S.S., S.P., S.K., S.V., and S.B. They are not patented and their composition is kept secret, but from information received from various sources, I believe that the Rifleite consists of soluble wood nitrocellulose dissolved in aceton and mixed with nitrobenzin and saltpeter, and granulated in a similar manner as the E.C. powder.

A very remarkable powder of this class is made by Hermann Guttler, of Reichenstein, in Germany, which is made by dissolving nitrated wood cellulose in molten dinitrotoluol.

To the miscellaneous class of smokeless powders belong really only two powders, which are both sold by the French government for sporting purposes. One kind is called Poudre Pyroxylée, and it is composed as follows:

Soluble guncotton	28 parts.
Insoluble guncotton	37 parts.
Barium nitrate	29 parts.
Potassium nitrate	6 parts.

Ether is used as a solvent with this powder. The other more recent one which was substituted for the Poudre Pyroxylée is the so-called J. Powder. This is due to the Engineer Bruneau, and consists of 83 parts of guncotton and 17 parts of ammonium bichromate. The Nobel Company, of Austria, also proposed to make a smokeless powder consisting of 70 to 99 parts of nitro-starch and 30 to 1 part of dinitro-benzin, but it does not appear to have been adopted yet.

There were various other powders proposed, such as that of Kaliwoda von Falkenstein, and that of Kolf and others, but these propositions have apparently been made by people not sufficiently conversant with the requirements of a good service powder, and they need not therefore be considered here.

One of the most important conditions in the preparation of smokeless powder is the proper selection of prime materials. I do not intend to give an opinion as to the relative value of the various powders and consequently of the constituents. Generally, nitrocellulose has been selected as a chief ingredient, and from the many nitrocelluloses available, the nitro-cotton, or guncotton, has been most favored. There are besides the nitrocellulose, many nitro compounds known which possess explosive properties, and give off no fumes, or very few, in burning, but nitrocellulose seems to have been selected, because it can be readily dissolved, and is well known, a solution can be mixed much more easily than a mechanical compound, and also because, after the solvent is evaporated, the nitrocellulose remaining can be shaped into various forms by easy mechanical means and without any danger.

The wood used for making nitrated wood cellulose was formerly, like the Schultze powder, cut up into thin squares. In modern smokeless powders, the wood pulp from the sulphite cellulose, or soda processes of cellulose manufacture, such as is supplied for paper making, has been used. This kind of cellulose is generally supplied from the factories in thin sheets, which are not very porous, have rather a glazed surface, and would have to be again reduced to pulp before it could be nitrated. A more convenient form and at the same time a very pure kind of cellulose has been made by the chemical factory of Waldhof. This cellulose resembles tissue paper, the difference being, that it is of looser structure, more like gauze, very porous and can be easily torn into small pieces by hand, so that it can be used direct for nitration. The wood cellulose has not yet been adopted by many factories, for the reason that it does not seem to give such a tough powder as guncotton.

I believe that it is unnecessary nowadays to refer at length to the well known differences between soluble and insoluble guncotton. Suffice it to say that it is generally recognized that the term soluble nitrocellulose means that kind of nitrocellulose which is soluble in ether-alcohol, but that it is not always of the same composition, since the amount of nitrogen contained in the soluble nitrocellulose may vary up to 12·78 per cent., and also the insoluble nitrocellulose may contain from 12·78 up to 14·14 per cent. of nitrogen. This does not mean that the soluble nitrocellulose contains an admixture of what is known as hexa, or insoluble, nitrocellulose. It may be a mixture of various kinds of soluble nitrocellulose, that is to say, of intermediate stages of nitration between mono and penta-nitrocellulose, but the whole of it must be soluble in ether-alcohol. At the same time, it is necessary that the nitrocellulose should comply with certain requirements laid down to adapt the powder made therefrom for the special purposes it is intended for.

Thus, for instance, certain powders will be made of a soluble nitrocellulose containing less nitrogen, and others from such containing the highest possible amount of nitrogen consistent with perfect solubility. As regards those powders where only the highest or hexa-nitrocellulose enters into the composition, it is apparent to all who are acquainted with the manufacture of nitrocellulose, that it has been hitherto impossible to obtain nitrocellulose containing 14·14 per cent. of nitrogen, that is consisting entirely of hexa-nitrocellulose. Generally the guncotton, which is the most used form of hexa-nitrocellulose, contains about 12 per cent. soluble nitro-cotton, but guncotton containing only 2 per cent. has been made by me on a large scale. In using hexa-nitrocellulose, one has therefore to be careful to regulate the amount of soluble nitrocellulose, which can be done either by blending or by using special means during the manufacture.

It was for some time known, and recently proved by Messrs. Nobel and Macnab, that by treatment at a temperature much below the freezing point of mercury, the so-called insoluble nitrocellulose is soluble in ether-alcohol, but these are conditions which are only obtained quite exceptionally. It has also been found by Prof. Odling that, by making special mixtures of nitric and sulphuric acids, it is quite possible to make two kinds of guncotton, both containing about the same amount of nitrogen, yet the one is soluble and the other insoluble in ether-alcohol. This has no other bearing upon the practical manufacture than that of showing the manufacturer how to avoid obtaining such results, which would be contrary to his intentions. What is generally aimed at, and what is nowadays quite possible, is to obtain nitrocellulose containing a definite amount of nitrogen and a suitable amount of solubility or insolubility.

Most military powders contain only the highest nitrocellulose, generally dissolved in acetic ether or aceton. In sporting powders, where less rapid action is desirable, soluble nitrocellulose is used, sometimes dissolved in a mixture of ether and alcohol.

Of the nitroglycerine used for the manufacture of smokeless powder, very little need be said, since nowadays there is no difficulty in producing a perfectly stable and in every respect suitable article. Of course, it is not so easy as it would seem from the indication given in text books. It can only be done in factories conducted on sound scientific principles, and having large experience at their disposal.

A very important feature as to the final composition of the powder is the solvent used. Although its complete evaporation is almost invariably aimed at, yet small traces of it, and especially such impurities as exist in the solvent, will remain in the powder. The nature of the solvent bears largely upon the structure and appearance of the dough prepared, and consequently, the finished powder may have a different density and a different surface, and thereby a different rate of combustion.

It is known that ether, by absorption of moisture, becomes acid in time, and although on evaporation the powder does seem to be technically acid, yet if proper care is not taken, it may not stand the heat test as well as it ought to. Aceton is a comparatively new solvent, and of that made on a commercial scale, very little was known. For use with smokeless powders, it has to comply with a severe specification. A good serviceable aceton should be quite clear and miscible in all proportions with distilled water, without any precipitate forming. It should not have more than 0·005 per cent. of acidity, nor more than 0·1 per cent. of aldehyde. With Kraimer's iodometric test (transformation into iodoform by an excess of iodine solution in the presence of soda solution) it should show at least 98 per cent. of pure aceton, and when treated with a 0·1 per cent. solution of permanganate of potash, it should retain its coloration for more than two minutes.

I have here a sample of aceton such as is used in very large quantities for military purposes. It has a specific gravity of 0·7965. Ninety-eight per cent. of this aceton distills over between 56·2 and 56·4° C. It stands the permanganate test for nine minutes and shows 0·00225 per cent. of acidity. An addition of alcohol to aceton has been tried and it seems to make the powder burn a little slower, but this can also be accomplished in other ways.

The nitrocellulose is, of course, dried at a temperature not exceeding 40° C. This is usually done in specially constructed drying houses, to which I have referred in a former paper before the society. I only wish to mention this on account of a peculiar process which was used in Austria as early as 1891 at least, but which was patented in this country in 1892. It consists in what they call the alcoholization of the nitrocellulose, namely, adding alcohol of high percentage to the wet nitrocellulose, diluting thereby the alcohol, and then evaporating the diluted spirit. Since the boiling points of dissolved alcohol and moderately diluted alcohol are very nearly the same, and since both are very much lower than the boiling point of water, it is clear that the removal of the moisture is done much more rapidly in this way. In order to utilize the alcohol more fully, one can, as it has been suggested in France, use the alcohol in separate stages, that is to say, using first diluted alcohol from former treatment, and after evaporating it, using the stronger one, which would have to deal with a smaller amount of water, and so on three or four times, whereby a considerable saving in alcohol would be effected.

I believe that in France, flat ebonite vessels were originally used, in which the guncotton was spread out in a thin layer, and the solvent poured over it. These vessels were then put under glass covers and allowed to stand until the solution was completed. Then a current of air heated to 55° C. was passed over it to evaporate the ether, and this was condensed in separate apparatus.

Nearly all powders are made up by very simple processes. The solution of nitrocellulose in the solvent is effected by means of kneading machines such as are used by bakers for preparing their dough, and which have long been used in the manufacture of blasting gelatine. Those of Werner and Pfleiderer are almost exclusively used. Their construction is shown in Fig. 1. It consists of a trough composed of two halves of a

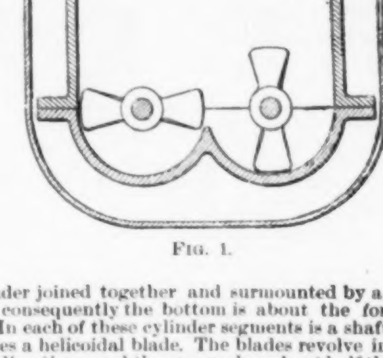


FIG. 1.

cylinder joined together and surmounted by a square box, consequently the bottom is about the form of a *w*. In each of these cylinder segments is a shaft which carries a helicoidal blade. The blades revolve in opposite directions, and the one makes about half the number of revolutions of the other. The blades very nearly touch the bottom of the trough, and the consequence is, that any material brought into the machine is divided into two parts, then kneaded against the bottom of the cylinders, then pushed along the blade, and by the next half revolution turned over by the other part of the helix; and since the velocity of the two blades is different, there will be with every revolution a different part of the dough submitted to the kneading operation.

As a rule, the mixture of smokeless powder, when once the solvent is introduced, ceases to be liable to explosion, and is only combustible, so that these kneading machines are usually made from iron only. Since guncotton has a very high absorbing power, the amount of solvent used is about weight by weight the same, but this varies according to the length of time given to the kneading operation. It is quite possible to work with a small amount of solvent provided the kneading of the mixture is prolonged sufficiently. The question as to whether it is more advisable to use a minimum amount of solvent, or to take a minimum length of time over the operation, has to be decided from economic consideration, since hitherto it has been found impossible to recover the solvent economically. When the dough leaves the machine, in which it has been kneaded from three to ten hours, it has a perfectly uniform and translucent appearance, and has about the consistency of soft India rubber. It then undergoes a further treatment according to the form which the finished powder is ultimately to have.

Some of the pure guncotton powders, like the Walsrode, is formed into grains by placing the mixture in hot water and blowing steam into it, which causes the dough to break up and become granular. Some are pressed through dies into cords, like the Cordite, of which mention will be made later on, but as a rule, for

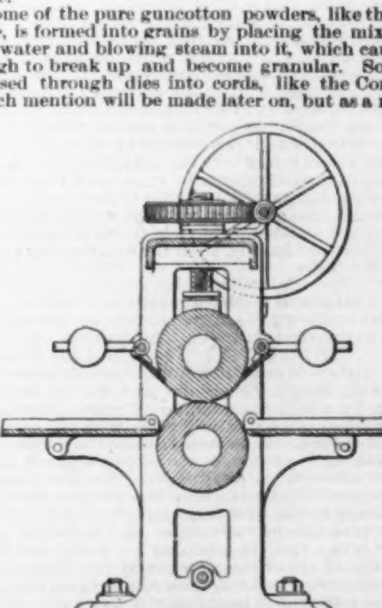


FIG. 2.

military purposes, the dough is passed between heated rollers, and rolled out into thin sheets, the solvent being simultaneously driven off by the heat from the rollers. The general principle of such rollers is shown in Fig. 2. They consist simply of a pair of hollow highly polished hard cast iron or steel rollers, the lower one of which rotates in a fixed bearing, while

the upper one can be elevated by means of gearing actuated by a hand wheel. Two scrapers are placed against the rollers to prevent the rolled out sheet from doubling up against the rollers and being carried round by them.

The temperature maintained in these rollers depends upon the boiling point of the solvent used, but it does not exceed, as a rule, 60° C. These rollers effect at the same time the thorough mixing and solution of any particles of nitrocellulose that may have escaped solution in the kneading operation. During the rolling there are occasionally small detonations heard, which were by some attributed to the bursting of air bubbles in the sheet, but are most likely due to some particles of guncotton exploding by combined heat, friction, and pressure, which is proved by local burning marks. Such explosions do not spread and are harmless. When the rolling out of the dough into a thin sheet of the required thickness has been effected, it is taken to a cutting machine, which cuts it up into small squares or flakes of the desired diameter. This cutting machine is shown in Fig. 3. It consists of a

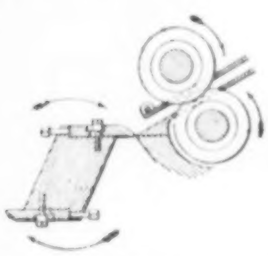


Fig. 3.

Fig. 4.

Fig. 5.

number of circular steel knives set in a shaft at a suitable distance apart, by means of distance washers; two such shafts stand opposite each other in such a position that the knives overlap slightly. There is a cob or grating fixed between the two sets of knives so as to take out the strip from the knife immediately it has been cut, and to prevent it being carried round and choking the cutter. By putting a sheet of powder between the two sets of knives, a number of strips are cut, which when they leave the circular cutters pass over a longitudinal knife-edge, in front of which are two or four longitudinal knives, carried on a revolving shaft, which cut up the strips into flakes. The length of a flake depends upon the velocity with which the strips pass from the knives and on the rate at which the chipping knives revolve. The velocity is regulated by means of cogwheels, and as a rule, the chipping knife is driven direct from the belt, and the cutting knives from this. The knives used for cutting strips were originally made, as shown in Fig. 4, with a small beveled edge, but this was found very inconvenient on account of the machine being easily choked. Nowadays, the form of the edge is generally that of a *u* as shown in Fig. 5, a form of knives which has long been in use for the purpose of cutting up Bristol board for playing cards.

In case the powder should have the form of cubes instead of thin flakes, the former are made by cementing together several sheets of powder. It would not do to make from the outset a thick sheet, because it would contain then a too large quantity of solvent, a great many air bubbles, and the mixture would probably not be thoroughly made. It is, therefore, better to conduct the whole operation by rolling out the mixture into thin sheets, and as there is a sufficient amount of the solvent left in them, cementing them into a thicker sheet by simply running several sheets together through the corresponding wider spaced rolls. Such cubes are perfectly translucent, and if cut normally to the surface, do not show the way how they are made, but if they are cut in an angle, the lines of division can be plainly seen. The powder after the rolling and cutting operations contains a small amount of the solvent, which on account of the homogeneous and tough consistency of the powder takes a good deal of time to entirely evaporate. It is, therefore, treated in drying houses, sometimes for more than a week, unless it is specially desired to retain a certain small percentage of the solvent. In very rare cases, it has been thought desirable to make round disks instead of square ones, and the machine adapted for that purpose is similar to that used for making certain kinds of pastry, namely, passing the dough through a die and allowing a knife to revolve rapidly against the cord issuing from the die, thereby cutting it into fine disks.

With Nobel's Ballistite, which contains a mixture of nitroglycerine and soluble guncotton, it was originally intended to absorb the nitroglycerine by the collodion cotton in the vacuum vessel, then to press out the excess of nitroglycerine, and to then heat the remainder of the mixture in order to dissolve the collodion cotton.

Later on, Messrs. Lundholm and Sayers devised a process by which the solution of nitroglycerine and nitrocellulose can be readily made without such complicated means. It is based upon the curious fact that, although guncotton containing a small amount of water is soluble only with difficulty in nitroglycerine, such guncotton is readily soluble when suspended with the nitroglycerine in a large quantity of water. For this purpose the nitroglycerine and collodion cotton are put into a vessel containing hot water and stirred by means of air, or steam, whereby the incorporation of nitroglycerine and collodion cotton takes place; but it is also sufficient to maintain the water at a temperature of about 60°, and to let the mixture stand for several days, stirring it from time to time. When the gelatinization is completed, the mixture is first submitted to pressure in order to remove the largest part of the water, and then formed into sheets under heated rollers, and finally cut and dried in the usual way. In Italy they form cords like those of Cordite and call the powder Filite.

As it is known that nitroglycerine alone will not dissolve the highest nitrated cellulose by ordinary means, collodion cotton is used in the manufacture of Ballistite. Sir Frederick Abel and Professor James Dewar found that they could make a perfect combination of guncotton and nitroglycerine by dissolving them both in a common solvent. The peculiarity in this process is, that although one would imagine that on evaporating the solution the two constituents would separate, since the one is not soluble in the other under ordinary circumstances, yet the two remain in a perfect combination, which has quite the appearance of the solution effected in the case of nitroglycerine and collodion cotton. It has been claimed by Abel and Dewar that they are not in solution, as a matter of fact, but are existing side by side.

In the manufacture of Cordite the guncotton and nitro-glycerine, together with a suitable amount of aceton, which is used as a solvent, are placed into the kneading machine and worked for 3½ hours, when the mass has a perfect dough-like appearance. At this stage a small quantity of vaseline is added, and the dough worked another 3½ hours, when the combination is considered to be perfect. During the kneading operation care is taken to prevent the escape of the solvent, and by means of a water-cooling jacket the heat generated during the kneading is reduced so as to prevent the evaporation of the solvent. The dough is then brought into machines which squirt it through dies into the form of threads or cords.

One of the machines is shown in Figs. 6 and 7. It consists of a base plate, A, and two columns, BB, connected by a head, C; between the two columns a cross head, D, slides up and down. The mould, E, is contained in the base plate, A, and held in tight by clamps, F; at the bottom of the mould, E, is a cover, G, with a nozzle, H, made to correspond to the thickness of the cord required. Another mould, I, which contains the dough, is put on the top of the mould, E. In the cross head there is a nut, K, which can turn, and which is fixed into the base of the cogwheel, L. Into this goes a screw, M, having fixed to it, by means of a cutter, the piston, M. The cogwheel is made to turn by means of an intermediate cogwheel, L 2, and a driving wheel, L 3. On the shaft of the cogwheel, L 3, there is a long feather key, N, and if, therefore, the crosshead rises for some reason or the other, the whole mechanism slides up on the feather without ceasing to revolve. It will be seen, therefore, that on being rotated by the cogwheel, the nut, the screw, and with it the piston, must gradually descend into the mould and press out the mass through the nozzle in the form of a thin cord. In order to prevent the pressure in the mould becoming too great from any cause—such as the die getting blocked by any foreign matter—there is a hydraulic arrangement provided. The crosshead is screwed fast with a hydraulic piston, in which the screw can work up and down freely; this piston works in a cylinder which forms parts of the head of the press. Hydraulic pressure is applied on both sides of the piston by means of the pipes, Q and R. Since the free surface of the piston is smaller on the lower part than on the upper one, there is always a pressure acting on the piston corresponding to the difference of the two areas. The amount of pressure is regulated by means of the safety valve, S, and should it exceed a certain limit, the water flows out through the safety valve, and the crosshead and piston ascend, when the whole of the contents of the mould are pressed out; the lever, T, is caught by a tappet, V. With this lever is connected another lever, W, and as T is moved, the lever, W, either lifts or presses down, by means of a rod, X, a counterweight, with the result that one driving belt is thrown on to the loose pulley and the other on to the fast pulley, and the motion of the piston reversed; in the same way the machine can be brought to a standstill altogether.

The cord issuing from the press is reeled, in a similar manner to cotton spools, on to drums made of sheet metal stampings. A number of these reels are re-reeled on to a large drum, and several large drums on a larger one, so as to obtain a uniform blending. The cord is then brought to a machine, where it is pushed several strands at a time into the cartridge and cut off at the proper length. With Cordite of a larger diameter, the cord is cut immediately after leaving the die into lengths of about 12 inches.

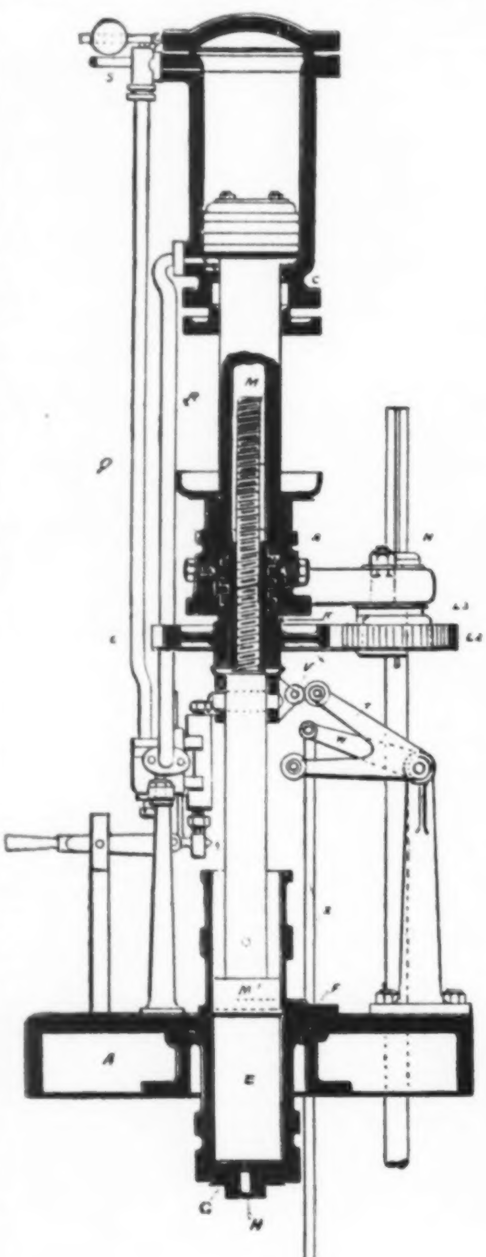


Fig. 6.

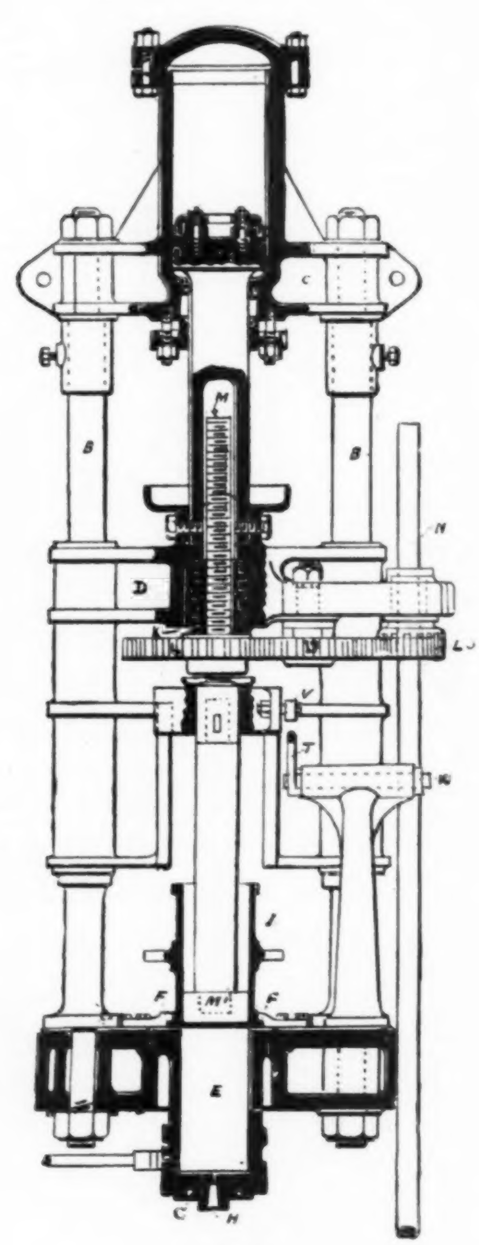


Fig. 7.

In the case of Amberite, the manufacture is somewhat different. First of all, grains are formed from the nitro-cellulose, probably in a similar way as it is done with the E. C. powder, and are subsequently treated with a solvent which dissolves the soluble nitrocellulose only—for instance, with sulphuric ether and alcohol. In this way, there is a kind of cement formed within the mass of insoluble guncotton, which binds the grains thoroughly together and yet leaves the guncotton unaltered. There is in this case, therefore, not only the hardening of the surface as in the case of the E. C. powder, but the formation of a kind of conglomerate throughout. This, of course, diminishes the rapidity of combustion of the powder a good deal. In order to arrive at a proper proportion of insoluble and soluble nitrocellulose, the patentees add the required proportion of soluble guncotton to the ordinary guncotton of commerce, which usually contains already about 12 per cent. of the soluble variety.

In the case of the Leonard powder, the materials are simply mixed with aceton and left standing for 12 hours in tightly closed pots, after which the solvent is evaporated and the mass granulated in the usual way.

(*To be continued.*)

AMERICAN BELLS.

MR. GEORGE M. CHRISTIAN, manager of the Williams Bell Foundry, Jersey City, reports having received an inquiry for a number of fire alarm bells for Tokio, Japan. The Japanese have been noted for their bells, but our American manufacturers seem to have surpassed their best efforts. The firm sending for the bells are natives of Japan, but do not hesitate to patronize American industries when it is to their advantage. The same firm shipped a number of large bells to South America recently. Several ranging from 1,000 to 1,600 pounds were carried inland two hundred miles by natives, swinging each bell on a long pole, with relays of natives every few miles. All the large fog bells (1,000 pounds each) on the North and East Rivers have been cast in this city.

American bells are recognized now in all the foreign countries as superior in tone to any other make. The largest bells have been cast in Russia, China and Japan. The immensely large bells which exist in the world, and of which mention is made in history, have always been objects of interest and wonder. Their existence is owing, doubtless to the tendency which semi-civilized nations exhibit toward displays of magnificence, as also to a religious enthusiasm which, in Christian countries, regarded the provision of these immense bells for churches, monasteries, etc., as being meritorious in proportion to their size. Both of these considerations tended to the production of the great bell of Moscow, of which every one has heard, at the casting of which it is recorded that the nobles from all parts of the empire were present, vying with each other in the value of the votive offerings, such as gold and silver plate, jewelry, etc., which they cast into the furnace.

THE KING OF BELLS.

The "King of Bells," as it is commonly called by the Russians, stands at the foot of the tower of Ivan Veliki, within the Kremlin, at Moscow, not far, probably, from the spot upon which it was cast from furnaces erected specially for that purpose. It is placed upon a circular wall or base of granite of about five feet in height and four feet in thickness. The grounds and buildings which surround this big bell are of immense size, and tend to dwarf its appearance in approaching it from the Redeemer Gate. It is not until the visitor has obtained a nearer view and measured it by his own size that he is able to realize the extent of its colossal proportions. It measures twenty-two feet eight inches across the mouth, nineteen feet three inches in height, and its thickness at the point where the clapper would strike is twenty-three inches. Its estimated weight is from 400,000 to 440,000 pounds. A nearly triangular shaped piece of about six feet in height by seven feet at the base, the estimated weight of which is eleven tons, is broken out of its side at the rim and stands upon the ground just below the opening thus formed. Besides this fracture there are eight cracks, distributed around the remaining portion of the rim at about equal distances, running up from three to seven feet, which cracks can only be accounted for upon the theory that the contraction of the metal upon the inner mould in cooling after casting (hastened, perhaps, by the accidental presence of water in the casting pit) caused it to split asunder, and two of these splits running together caused the piece to fall out. That the bell was rung—a question which has caused some discussion—is evident from the inscription upon its base. In placing it in its present position it was intended that it should be made to serve as a chapel, with which view an opening was left through the pedestal wall, which, with that in the bell above it, form an imposing entrance; but the present appearance of the interior would indicate that it was never consecrated or used for such a purpose. There are several religious figures cast upon its outer surface, among which is that of the Saviour, the Holy Virgin and the Evangelists, surrounded by cherubim. It also bears a representation of the Tsar Alexie and the Empress Anne.

THE RINGING QUALITY.

Any opinion as to what the ringing quality of the great bell might have been would, of course, be merely conjectural, but an examination of its proportions shows that it is rather too thick to have vibrated freely, while its tone would have also been impaired by the large quantities of silver thrown into the furnace as votive offerings at the time of the casting; recent experiments having shown that the introduction of silver into bell metal, contrary to poetical conception and popular opinion, only serves to deteriorate its ringing quality, it being, as compared with tin (the usual complementary ingredient with the copper), more of the nature of lead, and therefore incapable of producing a hard, resonant metal. As a casting, the great bell is a specimen of excellent workmanship, the numerous bass-relief figures upon its outer surface, together with its ornamentation and inscriptions, being brought out clear and distinct, while the section shown by the fracture exhibits homogeneousness of composition and solidity of structure. But for an unfortunate scab in the waist marring the outline of the drapery of the principal figure, the casting might be called perfect, an accomplishment difficult of attainment, owing to the immense strain and wash of the moulds occasioned by such a mass of molten metal, almost in proportion to the weight of the bell. In fact, judging from the mode of manufacture now employed in the extensive and celebrated Moscow Bell Foundry, it is probable that no improvements in the art of bell making have been introduced in Russia since the casting of the great bell, a remark that will apply, too, for a period of two centuries past, to any country in Europe. As for improvements in bell mountings, the Russians have no mountings for their bells. They simply suspend them stationarily from beams and sound them by pulling the clapper, so that the effect is that of tolling instead of ringing. All preparations and work, except price of metal, of the great bell of Moscow, cost 62,000 rubles, nearly $47,700. The total cost was about $300,000.

OTHER BELLS.

Among other bells noticeable for their size might be mentioned that of Erfurt in Germany, weighing 30,000 pounds, which was cast in 1479, and was long distinguished as being not only the largest but the best in Europe. In Vienna and Olmutz are bells of 40,000 pounds each, cast in the last century; while that of Notre Dame Cathedral at Paris, cast in 1680, weighs 30,000 pounds. The bell of St. Peter's at Rome weighs 17,000 pounds; that of St. Paul's, London, 11,000 pounds; that in York Minster, called Great Peter of York, 27,000 pounds; the Parliament House bell, in London, 30,000 pounds; Great Tom of Lincoln, weighing 10,000 pounds, cast in 1680, was long celebrated as the finest bell in England, but becoming cracked was recast in 1885. The celebrated Great Tom of Oxford, which hangs in the tower of Christ Church and strikes 101 times every evening at nine o'clock, weighs 17,000 pounds and was cast in 1630.

There is a bell in Pekin, China, which weighs 120,000 pounds; it is fourteen feet high and twelve feet in diameter. The Chinese formerly made their bells nearly square in shape. At one time it was the custom to make bells of several pieces of metal welded together, but these necessarily lacked vibration and were useless. The metals used in the manufacture of the oldest bells of which we have any record were the same as those now in use, namely, copper and tin. The long experience of the ancients, as well as the careful tests of later years, has clearly proved that these are the only metals capable of producing a proper alloy. The largest bell in America is in the Cathedral of Montreal; its weight is 28,000 pounds. That in the Public Building in Philadelphia is to weigh between 20,000 and 25,000 pounds.

SPRAY TANNING.

By P. F. REINSCH.

OF the many attempts which have been made to improve the tanning process, having for their object a more rapid output and a more complete utilization of the tanning material, none has proceeded on any plan other than that of immersing the hide in the tanning liquor.

"Spray tanning" (Rieselgerbung) consists in causing the tanning liquor to flow down each side of the vertically suspended hide, stretched by its own weight; the liquor is received in a tank and pumped back into the reservoir from which it flows.

The plant necessary for the process consists of a number of frames, from which the hides are suspended by hooks, a reservoir supplying pipes which carry equidistant jets, so arranged that the liquor may flow on to each side of the hide, and a tank to receive the partly spent liquor. To secure equable tanning the liquor must be constant in rate of flow and in strength; the first desideratum is secured by keeping a constant level in the reservoir, the second by adding strong liquor to maintain the specific gravity of that pumped back into the reservoir at the same figure.

The duration of the tanning is alleged to be reduced by this process for heavy leather to one-eighth or even one-tenth of the time expended in the usual layer process, and it is claimed that the product is equal in quality to that turned out by the old method.

It will be observed that in spray tanning both hide and liquor are exposed to the air. While this is of no moment when the process is used for mineral tannage, it is not permissible when tannin itself is used, for the tannin speedily suffers oxidation and is lost so far as the tanner is concerned. This difficulty is by no means insurmountable, inasmuch as the maintenance of an atmosphere of carbon dioxide around the hides is not difficult; all that is required is a box which shall be air tight at the bottom and sides, with a pipe for admission of the gas into the lower part; according to the author, the gas will remain unmixed with air for weeks, even if the box be not covered.

A noteworthy economy effected by spray tanning is that handling and plunging are not necessary; another is the complete utilization of the tannin, which is most effectively extracted from each drop of liquor as it trickles over the hide. It is also in favor of the new process that it requires a smaller ground space and a less expensive installation than are required for pit tanning. If a comparison of the two processes be made on the basis of the space necessary for laying away 600 hides, it will be found that the space for pit tanning will be $\frac{100}{87}$ times that necessary for spraying, or $\frac{100}{19}$ times if the latter process be conducted in two tiers. The cost of 28 pits is given as 4,480 marks, that of an equivalent spray apparatus as 2,000 to 3,000 marks.

Spray tanning was specially devised for the author's ferric oxychloride and salt method of tanning. The following figures are claimed to be representative:

	Time occupied in tanning by		
	Tannin in Pits	Ferric Oxychloride in Pits	Ferric Oxychloride in Sprays
	Days	Days	Days
Light leather	50	11	1
Heavy leather	140	28	24

COST OF TANNING MATERIAL FOR ONE KILO. OF RAW HIDE.

	Pfennige
Bark	105
Chromium compounds	15
Ferric oxychloride and salt	5

LABOR BILL FOR 100 KILOS. OF RAW HIDE.

	Marks
Bark tannage	21–19
Chrome tannage	20
Ferric oxychloride spray tannage	8

Iron tanned heavy leather is asserted to compare favorably with the best bark tanned heavy leather. The grain is particularly durable, and the resistance to water is considerably greater than that of bark tanned leather. For belts the iron tanned leather is more valuable than bark tanned, as it does not deteriorate so rapidly when exposed to dry or moist heat.—Dingler's Polyt. J.

THE LUCANIA AND THE CAMPANIA.

THE two fastest and most remarkable ocean steamships now in service are the above vessels of the Cunard line, now plying between New York and Liverpool. They are sister ships, of same size and power. From a recent article in the *Engineer*, London, we abstract the following: Each ship has two main engines, each intended to indicate 15,000 horse power, and that power has actually been obtained. We believe, however, that the average working power is 28,000 horse power for the two. They are peculiar in arrangement. Each engine has five cylinders and three cranks. There are two high pressure cylinders 37 in. in diameter. These stand each over a low pressure cylinder, 98 in. in diameter, a single piston rod serving for each pair of pistons. Between the two low pressure cylinders is placed one intermediate cylinder, 79 in. in diameter, into the valve chest of which both the high pressure cylinders exhaust. The stroke of all the pistons is 69 in. The capacities of the cylinders are to one another roughly as 10 : 49 : 75. But inasmuch as there are two low pressure and two high pressure cylinders to one intermediate, the real proportions come out very nearly as 21 : 49 : 150, or as 3·7 and 20·3. If steam were cut off at half stroke in the high pressure cylinder, and the effect of clearance neglected, the total expansion would be about 13·5 to 1. The safety valves are loaded to 165 lb., so that if we take the initial steam pressure as 175 lb. absolute, the terminal pressure would be a little under 13 lb. absolute. This is, of course, higher than that obtained in practice, for sufficiently obvious reasons. Various changes have been made in the propellers of the Lucania and Campania, and we do not know what is the precise number of revolutions made per minute now. We shall not be far wide of the mark, however, if we take it at a little more than seventy-one, corresponding to a piston speed of 820 ft. per minute. The two high pressure pistons have piston valves. The propellers are three bladed, of manganese bronze, cast at Fairfield. The total weight of the six blades of the two propellers is 48 tons.

The engines are 47 ft. high from the base to the top of the high pressure cylinders; that is about the height to the top of the roof of an ordinary three-story house.

The crank shafts are each made of three pieces, and each piece weighs 27 tons. The thrust shaft is 16 ft. long, and weighs 29 tons; the crank shaft is 26 in. in diameter; the propeller shaft, 24 in.; the total weight of crank and thrust shaft, taken as a whole, is 110 tons; each of the six connecting rods weighs 10 tons.

No particulars have ever been made public concerning the quantity of coal used per day; but it is not difficult to arrive at fairly approximate figures, and these are startling enough. It is said that the City of Paris and City of New York—now the Paris and the New York—get on with 350 tons per 24 hours. This may or may not be the case; but it is easy to see that the Lucania and Campania must burn much more. As we have said, we believe it to be pretty certain that these ships each require 28,000 horse power to propel them at the enormous speeds which they so regularly maintain. The auxiliary engines in such a ship use a great deal of steam, which is not included in this 28,000 horse power. The main engines are no doubt economical, but we cannot think that we shall be far wrong if we take the weight of steam used, all referred to the main engines, as 16 lb. per hour per horse, which at 8 lb. of water per pound of coal, represents 2 lb. of coal per horse power, a very good result under the circumstances. It is possible, of course, that the consumption may be less than this, the evaporation higher; but the one cannot be much less, nor can the other be much smaller.

Taking, then, the coal at 2 lb. per horse per hour, we have 56,000 lb. or 25 tons of coal per hour, or 600 tons a day. That is to say, the consumption per day equals the contents of two 30-wagon coal trains.

Through the engines will pass $8 \times 25 = 200$ tons of steam per hour, or $3\frac{1}{3}$ tons of steam per minute; the feed water will require to pump it into the boilers about, when allowance is made for pipe friction, etc., 100 indicated horse power. The feed water, taking 36 cubic ft. to weigh a ton, will fill a tank 10 ft. wide, 10 ft. deep, and 72 ft. long.

To condense the 200 tons of steam about 7,500 tons of water is pumped each hour through the condensers; that is to say, about one-half the weight—displacement—of the ship. This water would fill a tank 20 ft. wide, 10 ft. deep, and 1,350 ft. long, or it would fill a dock 337 ft. long, 40 ft. wide, and 20 ft. deep. Flowing over a weir, this volume of water would represent a not inconsiderable trout stream. It is moved, however, with a very small expenditure of power, because there is virtually no head against the centrifugal pumps.

In the boilers—twelve main and two auxiliary—there are 102 furnaces. In each there is nearly 26 square ft. of grate surface, or, in all, 2,625 square ft. That is the area of the floor of a great hall, 52 ft. long and 52 ft. wide. Fifty tons of coal are required to charge the furnaces, and that is the quantity burning at one time. To burn 56,000 lb. of coal in an hour on these grates, about 25 lb. of coal must be burned per square foot per hour. This is not more than we should expect, seeing that the tops of the chimneys are 120 ft. above the grate level, and that very special facilities have been provided for the supply of air to the fire rooms, although forced draught is not employed. Allowing 20 lb. of air to burn each pound of coal, 250 tons of air per hour must pass up each of the great chimneys, 19 ft. in diameter and 130 ft. apart. This, at the probable temperature at the top of the funnel, would occupy a space of about 11,200,000 cubic ft.

The Campania has steamed from Sandy Hook to Daunt's Rock at an average speed of 21·28 knots per hour. But taking 21 knots as her velocity, she passes over 2,130 ft. per minute. In the same time her pistons make 800 ft. The speed of the ship is thus $2\frac{5}{8}$ greater than that of the pistons. If we take the length of the passage as 2,812 knots, then each piston passes over a space of 1,057 knots, and as there are six pistons, the total distance they make is 6,342 knots. Those of our younger readers who are fond of graphics may find it interesting to plot the path in space of one of the pistons from the data we have given. It will be seen that the relation between the speed of a piston, and that of a ship is very important. It is evident, for example, that if half the whole power, or 14,000 horse

power, were referred to the low pressure cylinders of each engine, the average total pressure on the piston could not be less than 2⅔ times half the resistance of the ship. But as in all probability the thrust effort, multiplied by the velocity in feet per minute, does not exceed one-half the whole horse power, then the piston effort must be twice half the whole resistance. We say half the whole resistance, because there are twin screws. The total thrust on the two blocks will in all probability not much exceed 100 tons, or say 50 tons on each.

It will be seen that we have taken the consumption at 600 tons per day of twenty-four hours, and it may be said that this is an exaggeration, and that the consumption is really much less. This may be the case; but if so, then either of four things must take place: 1, the engines do not use 16 lb. of steam per horse per hour; 2, they do not indicate 28,000 horse power; 3, the boilers evaporate more than 8 lb. of water per pound of coal; or, 4, any two, or all three, of these suppositions are facts. Now as regards the first point. It will be admitted that a consumption of but 16 lb. of steam per horse per hour represents a very good engine indeed. We are quite aware that higher duties by four, or possibly five, pounds have been attained, but not at sea, and only under almost exceptional circumstances on land. In this 16 lb. we have included, be it remembered, all the steam used in driving, pumping, and electric lighting engines; for heating, and all the thousand and one uses to which steam is put in a great ship, and all used, be it observed, more or less uneconomically. As regards the second point, we have every reason to believe that the power exerted is more nearly 30,000 horse power than 28,000 horse power.

There remain only the boilers to be considered. There is nothing about them specially economical; nor is Welsh coal used, nor is the feed water supplied at a high temperature. We hold, therefore, that an evaporation of 8 lb. per pound of coal would be a very fair duty. But it will be seen that even if the boilers evaporated 9 lb. instead of 8 lb., it would only affect our calculations by one-eighth. The Cunard Company, following the example of the White Star, and indeed of all other Atlantic companies, refuse to make their coal consumption known. We have, of course, no desire to break through this wall of reserve. But, on the other hand, it is open to all engineers to speculate, as we have done, on what the probable consumption of the ship must be, and we hold that if the entire horse power in the ship, auxiliaries and all, is obtained at the rate of 2 lb. of North country or American coal per horse power per hour all round, the result is very satisfactory. Every passage across the Atlantic is in a measure a race against time, and little account of economy is taken as compared with speed.

It is now time to say something concerning the performance of these phenomenal ships, which have been steadily augmenting their speed almost from the first. Last November the Lucania held the record for the fastest westward passage across the Atlantic, the run being made in 5 days 12 hours 47 minutes, the average speed being 20·93 knots. The Campania, on the other hand, held the record for the quickest eastward passage, the run being made in 5 days 12 hours 7 minutes, or at an average speed of 21·28 knots. The figures are as follows:

LUCANIA'S WESTWARD PASSAGE.

	Knots.
Daunt's Rock, 12:55 P. M., October 29, to noon October 30	481
October 31	542
November 1	536
November 2	490
November 3	535
To 9:7 P. M., November 3, Sandy Hook lightship	196
Total	2780

CAMPANIA'S EASTWARD PASSAGE.

	Knots.
Sandy Hook Lightship, 9:10 A. M., October 28, to noon	47
October 29	491
October 30	490
October 31	491
November 1	505
November 2	495
To 1:52 A. M., November 3, Daunt's Rock	293
Total	2,812

These figures may be compared with those of the performance of the rival ships Paris and New York. They represent average and not exceptional passages for all four ships:

AVERAGE PASSAGE.

	Queenstown to New York.	New York to Queenstown.	Knots per hour.
Campania	5 d. 20 h. 18 m.		20·06
		5 d. 17 h. 27 m.	20·76
Lucania	5 d. 14 h. 27 m.		20·64
		5 d. 20 h. 50 m.	19·90
	Southampton to New York.	New York to Southampton.	
Paris	6 d. 15 h. 14 m.		19·30
		6 d. 22 h. 23 m.	18·65
New York	6 d. 20 h. 50 m.		18·66
		6 d. 20 h. 30 m.	18·89

There is, however, a later performance than any of those we have given. The following extract from the *Liverpool Mercury* of May 28, 1894, gives the particulars of a very remarkable round trip made by the Lucania: "The westward passage across the Atlantic is usually the most trying and protracted, but on rare occasions a vessel will carry easterly winds with her throughout it. The record passage in that direction was 5 days 12 hours 47 minutes, on the northerly route, for a total distance of 2,780 knots. The passage has now been made in only ten minutes longer time on the southerly route of 2,873 knots, or a greater distance by 93 knots. It has been done, too, in spite of the fact of six hours' fog being encountered, during which the vessel proceeded at reduced speed. On the 19th instant, the American Line steamer New York took her departure from the Needles at 1:35 P. M. The Cunard steamer Lucania took hers about twenty-three hours later from Daunt's Rock, Queenstown, and arrived at Sandy Hook Lightship about four hours sooner, having averaged over two knots an hour greater speed than her American competitor. The Lucania now excels all records in ocean steaming, in having made the round trip from New York and back again at an average speed of 21¼ knots per hour over a distance of 5,784 knots. The fastest railway express in the world could not thus maintain an average speed of 25 miles an hour over a distance of 6,660 miles, with only one break on the journey. Had the Lucania sailed on the short route, on which her record voyage was made, her passage would have been 5 days 8 hours 39 minutes. Her sister ship, the Campania, has already averaged close on to this speed on one trip, but on her present homeward voyage met with easterly gales and high confused seas throughout the passage, besides some fog, through which she was delayed, leaving New York beyond her ordinary time. Nevertheless, her passengers, the largest number that ever left New York so early in the season, were landed in Liverpool on Saturday afternoon."

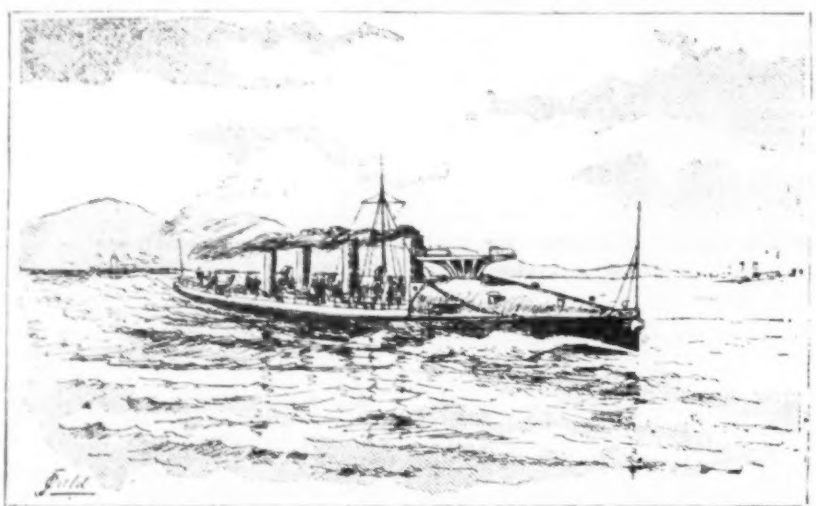
Although we have already very fully described the Lucania, it may be convenient to reproduce here the following figures which serve to emphasize the progress which has been made in Atlantic navigation. The first steamer possessed by the Cunard Company was the wooden Britannia, which started on her first voyage to Boston from the Mersey on the Fourth of July, 1840—that is to say, just 54 years ago.

	Britannia.	Lucania.
Length	207 ft.	620 ft.
Tonnage	1,150	12,950
Horse power	740	30,000
Speed	8½ knots	21½ knots
Consumption of coal per day	38 tons	600 tons
Passage	14⅓ days	5½ days
Accommodation	115 passengers	1,400 passengers

The crew of the Lucania is divided into three departments, and numbers all told, sailing 54 hands, engineers and firemen 190, and stewards 179; total 423 hands.

H. M. S. FERRET.

The Ferret, a twin screw torpedo boat destroyer of the Hornet class, which has been built by the well-known firm of Laird Brothers at Birkenhead, was recently put through her official trials for speed on the measured mile at Skelmorlie, on the Clyde, a few miles below Greenock. The Daily Graphic says the average speed estimated from six runs was 27·62 knots, and throughout these and other trial runs the engines worked without any hitch. The numerous funnels and high turtle back give the Ferret and her class a most peculiar appearance. The big circular platform forward is for the reception of a 12-pounder quick-firing gun which will have an almost complete circle of fire. The Ferret will be further armed with three small quick-firing guns and three torpedo tubes.



THE NEW BRITISH TORPEDO BOAT DESTROYER FERRET.

ROPE BRIDGES AND THEIR MILITARY APPLICATIONS.

Much attention has been paid for some years past to the subject of the quick repairing of railway bridges in time of war by means of a materiel all prepared in advance. The experience of the last campaigns, from the war of the rebellion to the Turko-Russian war, has proved, in fact, that local resources are in most cases inadequate to permit of effecting such repairs quickly enough, even though one has at his disposal, as in America, inexhaustible forests from which may be obtained at will the wherewithal to construct the huge scaffoldings or trestles that form the simplest while at the same time the most rudimentary means of crossing a gap.

We have many times described the various systems of metallic bridges proposed by our engineers to satisfy every military engineer. Some, such as Col. Marcille's

Fig. 1.—PUTTING A GISCLARD BRIDGE IN PLACE.

bridge, consist of wholly mounted and relatively heavy sections, that are carried by rail and assembled end to end. Others form reticulated systems capable of being taken apart up to the extreme limits at which the pieces can be carried by men, thus permitting of their being moved to any point whatever, even though no railway reaches it. This is a great advantage for the simultaneous reconstruction of several bridges situated upon the same line. The bridges of this nature are numerous. It will suffice to mention those of Mr. Eiffel and Lt. Col. Henry. Both have been the object of numerous experiments that have shown all the resources that they offer to the engineer, not only in case of war, but also in time of peace, when it is a question of promptly remedying an accident, as at Artemare, or of forming a provisional passage without travel being impeded, as at Argenteuil, and also recently on the Ourcq canal.

These various systems respond to a well defined and limited need, but it is not useless to ask whether, aside from railway bridges, it will not be possible, by the same process, to assure of the re-establishment of bridges situated upon ordinary roadways. Although there is no doubt, in fact, that the technical problem may be easily solved by means of metallic bridges and light foot bridges easily put in place, it is not less evident that, in time of peace, there might be constructed and preserved the large quantity of equipments that would be necessary, so that, at the proper time, one might be almost sure of having some of them wherever the need thereof might be felt. Without speaking of the impediment that they would prove to armies that had to carry them in their train, it is certain that this accumulation of materiel would be out of proportion to the object in view. To cite an example of the multiplicity of needs which it is necessary to fulfill, it will suffice to remark that in certain broken

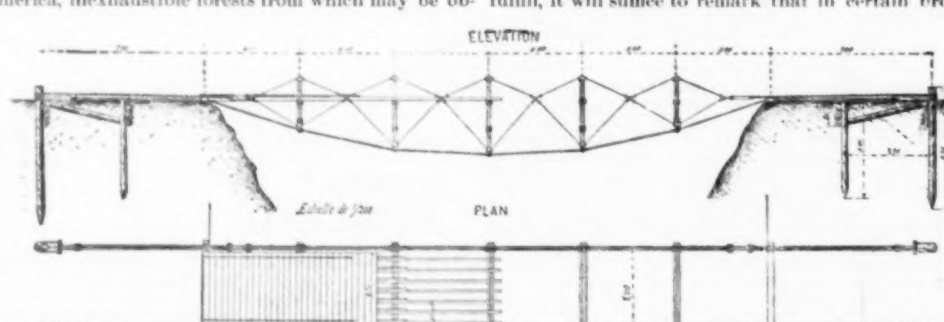


Fig. 2.—ELEVATION AND PLAN OF THE GISCLARD BRIDGE.

regions it is not rare to find, on a stretch of a few miles, five or six large bridges, the breakage of which would constitute a great obstacle, and which it would be absolutely necessary to repair in order that the army might pursue its way. No material interest would be able to suffice for the reconstruction of so numerous bridges and satisfy like exigencies so often repeated. As in the past, we shall therefore have to rely again, in great part at least, upon local resources, put to profit by the engineer corps.

We have only to look at the diversity of the processes brought into requisition in past wars by the military engineers, in order to get an idea of the complexity of the problem. There is no general method applicable to all cases, and every one endeavors to adopt the equally varied materials and resources that he has at hand to the varied circumstances that present themselves.

However, it would not be impossible to classify this multitude of more or less brilliant solutions and to prepare at least for the utilization of these chance materials by carrying along the light pieces whose manufacture requires a length of time out of proportion to what one

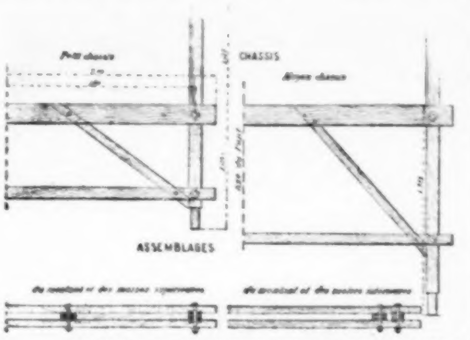


Fig. 3.—FRAME OF THE GISCLARD BRIDGE.

has at his disposal. It was thus that the Americans operated under many circumstances during the war of the rebellion. The system of lattice girders that they often adopted was very effective. The wood was easily found in situ, and it therefore sufficed to carry along the pieces of iron that were to serve for the uniting of the various frameworks.

In Europe it will not often be possible to depend upon wood of large section. Thus, the passage of the Danube in 1877 presented very serious difficulties, due to the want of raft wood, of which the markets had been drained in advance. In default of forests or well stocked yards, the demolition of the neighboring houses (which would not be a very economical means, nor a very humane one in time of peace) will always permit of finding the materials that are the most indispensable for the construction of a foot bridge. It will be the duty of military engineers to determine the best conditions for the use of them, in order that the crossing of a chasm may be effected as rapidly as possible, and it will be then that it will be important to make a judicious selection from among all the processes known and practiced.

Among such processes, it seems that, up to the present, sufficient attention has not been paid to funicular arrangements, which lend themselves so well to a rapid construction with light materials.

Apart from the timber, which may be found everywhere, it suffices to carry some ropes, assembling irons, and pulley blocks, all of which are objects that do not weigh much and do not cause an exaggerated encumberment. As for the work itself, that can be done without calling in the aid of a large number of special laborers.

The use of rope bridges by armies dates back to remote antiquity. It was a bridge of this kind that Xerxes threw across the Hellespont, if we are to believe tradition, his ships being used to form the intermediate points of support.

Rope bridges, moreover, are so easily improvised that past wars offer us numerous examples of them, from the legendary tentative of the king of the Persians up to the repairing of the bridge of Romans, upon the Isere, effected in 1814 by the French army. There are two great classes of suspension bridges having different properties which designate them more especially in different cases.

SUSPENSION BRIDGES WITH PARABOLIC CABLES.

These lend themselves well to permanent construction and permit of crossing with spans. The horizontal floor is suspended from the cables by means of a series of vertical supports. The extremities of the cables pass over piers or posts whose height measures, so to speak, the ordinate of the parabola at the starting point. This sort of bridge was much in favor half a century ago, and its technique is so well known that one may be sure of giving it a sufficient rigidity. From a military standpoint we know that troops and material can pass over it, provided the foot soldiers do not keep step and the wagons are not allowed to accumulate thereon.

When, however, it is a question of military applications, that is to say, of the rapid establishment of a crossing by means of a light material, the parabolic cable bridges lose nearly all their advantages. The installation of the shore piers is difficult, and the anchorages to the abutments are so much the more precarious in proportion as the traction is exerted more vertically.

The gravest inconvenience resides in the impossibility of obtaining sufficient stability in such a system, for which the ratio of the accidental supercharge to the dead weight of the bridge is much too great, in consequence of the necessity of having an easily transportable material. Under the action of the loads that cross the bridge, the conditions of equilibrium vary at every instant, and, as the elements of the structure are indistortable, there results for each position of the load a particular form of equilibrium of the whole, that is to say, a new distortion. In consequence of the tendency of the different points of this flexible system to return to their primitive position of equilibrium by a series of oscillations, it will be seen that in addition to the successive distortions that it will have to undergo, the bridge will be submitted to a vertical tremulous motion, which the light structure of the flooring is ill adapted to resist. These rapid considerations permit of the conclusion that bridges of this kind are not adapted for military applications, because of their dangerous mobility and the difficulty of establishing them.

BRIDGES UPON CHAINS.

Nothing simpler than these could be imagined. It suffices to stretch properly from shore to shore two chains, and to lay the flooring directly thereupon. As the traction is exerted horizontally at the anchorage points, it is easier to obtain strong attachments; but, on another hand, however strong be such traction, it cannot reduce the pitch beyond all limits, and, when the span reaches forty meters, the pitch is such that the flooring will be strongly incurved, and this sometimes renders the passage of it difficult to carts.

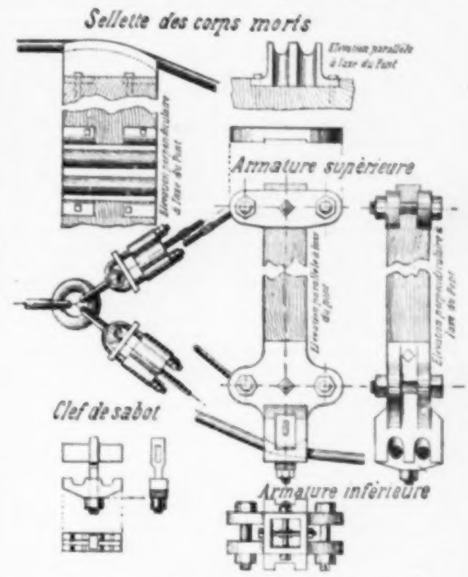
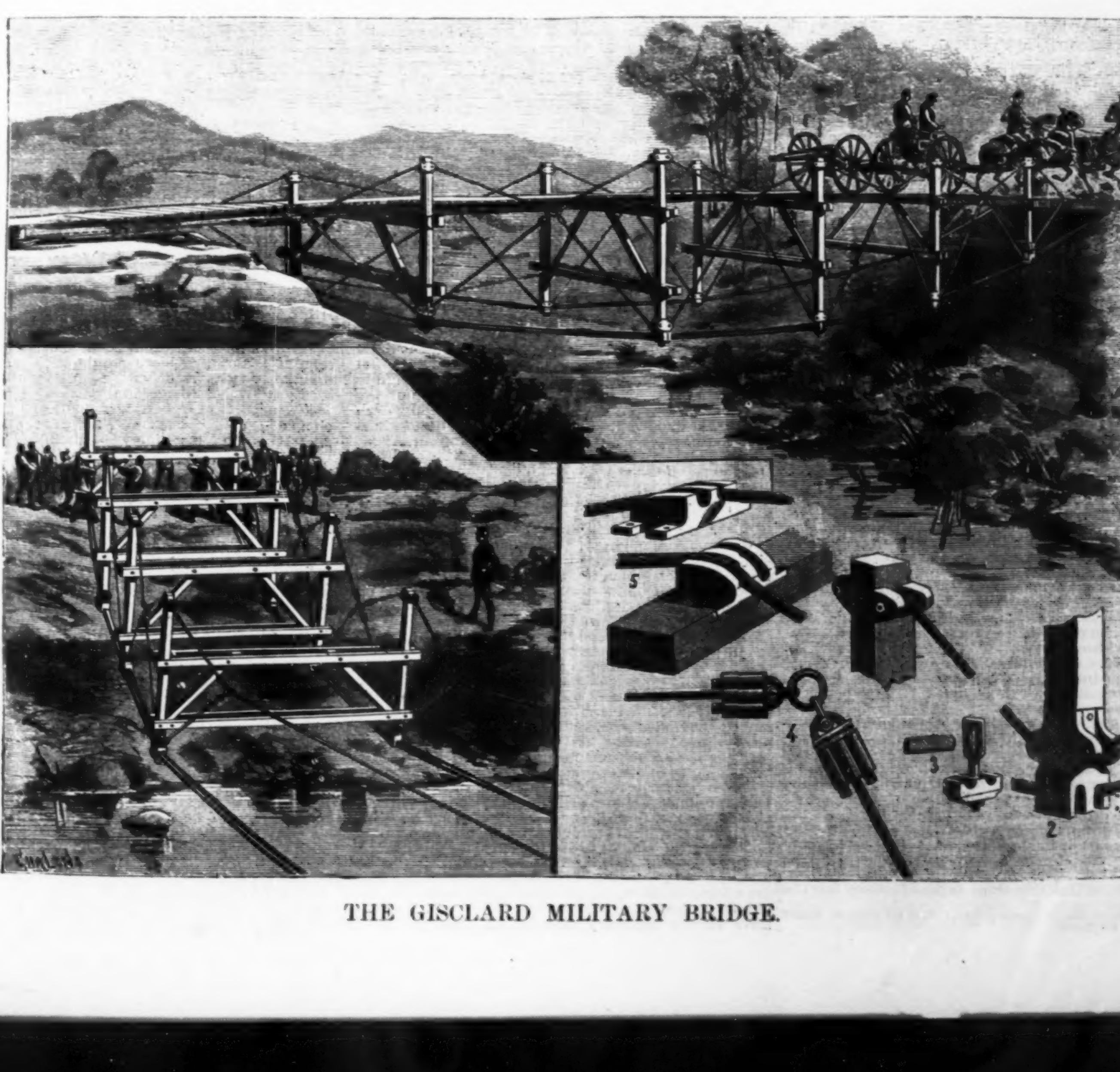


Fig. 4.—DETAILS OF THE BRIDGE.

However, the influence of the displacement of the accidental supercharge plays a much less important role in this system than in the parabolic cable type, in consequence of the initial tension of the cables. There results from this a much greater stability. It is certainly on account of this advantage, in conjunction with the ease of construction that it presents, that this type should have received numerous military applications.

It may be asked whether it would not be possible to devise a funicular system that should participate in the advantages of the two types that we have just examined and devoid of their principal inconveniences.

The efforts of the builder should tend toward the construction of a true trussed bridge, for which it is



THE GISCLARD MILITARY BRIDGE.

not necessary to exclusively employ ropes, which do not lend themselves to tractive stresses, while local resources will, in most cases, permit of improving rigid elements capable of working by compression.

The simplest solution would be to construct an inverted truss with a certain number of pendent joggle pieces sustained upon cables, which, with them, form an indistortable reticulated system.

This process, which theoretically seems perfect, does not take sufficient account of the special exigencies which, in this particular case, arise from the mobility of the load. Under such conditions we cannot consider the materials employed as inextensible, and this renders impossible a definite regulation. The load in moving along the flooring causes the latter to take on a variable curvature, and the stresses that result therefrom upon the different pieces may likewise undergo abrupt variations of intensity and even of direction. Nothing is more prejudicial to the preservation of the assemblages. The bolts and even the rivets, pulled successively in the two directions, finally begin to play in their recesses and quickly undergo a wear. Besides, in the combinations employed, it should be seen that the stresses are not too suddenly transmitted from one element to the other of the trussed girder, for, in this case, practice teaches that it is necessary to give the pieces a resistance double that which would be sufficient for them if the load acted progressively.

As may be seen, the problem is more complex than it would seem at first sight. A very distinguished government engineer, Commandant Gisclard, has been endeavoring for a few years past to get around these difficulties, and has devised some types of rope footbridges that are capable of rendering genuine service, even outside of cases of war.

The first type devised and experimented with in 1888 by the commandant may be classed with as much reason in one as in the other of the two classes of suspension bridges that we have just examined in succession. It is a parabolic cable bridge in which the cables are wholly situated beneath the plane of the ground. The flooring, instead of being suspended from the cables, is supported above them by compressed pieces.

On the other hand, the entire system is very taut horizontally as in the case of the chain bridge. The pieces serving as supports to the flooring are wooden ties spaced four inches apart. Their uprights are provided beneath with a stirrup which rests upon the cables.

In order to maintain the verticality of the uprights and the rigidity of the whole, there is arranged between two consecutive uprights four stays in the shape of metallic cables united at the level of the flooring by rings of forged iron so as to form a triangular reticulated system. The stays attached to the extreme uprights are tautened by means of pulleys fastened on the back to the anchoring posts of the parabolic cables. Since the abutments, as may be seen, have to undergo merely horizontal tractive stresses, they are easily established.

The upper guys are each formed of a single cable 20 mm. in diameter and weighing 1·7 kilogramme to the running meter.

The accompanying figures will permit us to dispense with a completer description of the arrangement adopted by Commandant Gisclard.—Le Genie Civil.

THE RELATION OF THE DRAWING OFFICE TO THE SHOP IN MANUFACTURING.*

By A. W. Robinson, South Milwaukee, Wis.

The purpose of this paper is to describe the system employed by the writer in the drawing office of his company, in the hope that some of the points may be of use to members of the society. The drawing office is the origin of thought and action for the entire works as far as the design and construction of its product are concerned. It is responsible for the accuracy of its drawings and orders, and its authority should be unquestioned and above reproach in the shop. The shopmen should habitually trust and adhere to their drawings, and their faith should not prove to be misplaced. To maintain this there must be unceasing care and vigilance on the part of the office, and full adaptation to the shop needs and capabilities. It goes without saying that every drawing office, whether employing one draughtsman or a hundred, should have its system and methods adapted to the needs of the establishment with which it is connected. As these needs vary with each case, it is not to be supposed that the system about to be described will be of universal application. It will be well, then, to state in a general way the conditions which this system is intended to meet. We will assume, therefore, that the office employs from ten to fifteen skilled draughtsmen, and is in connection with a manufacturing establishment doing a general engineering business in which there is comparatively little duplication of orders, and in which single orders frequently involve a large amount of detail, of which it is essential to keep exact records. It is also assumed that the dawing office is invested with the sole right and authority to issue orders to the shop for all new work, or all work in which there are changes and variations from previous similar work. The practice of issuing verbal orders or directions for the conduct of work is productive of misunderstanding and confusion. When no evidence of authority exists, no responsibility can be fixed. It is therefore advisable to have a system of written orders to all departments whereby the duty of those concerned is clearly defined, and the responsibility can be fixed for dereliction of duty.

Shop Orders.—An order being once entered on the books of the company, the procedure is as follows: The business office issues a written order to both the drawing office and the shop upon a blank which merely states the general name of the machine, the time of delivery promised, and the number of specifications to be worked to, if any, and the number by which the order is to be known. It is the duty of the drawing office to prepare such specifications beforehand where necessary. On the receipt of these orders in the shop, if it be a repair or duplicate of something already made, so that the shop superintendent has the information by which to execute it, he does so. If, however, it is new, or in any sense special work, he cannot proceed until the orders come down from the drawing office. The drawing office issues orders upon the pattern shop and foundry by means of blanks headed "Foundry" or "Pattern Shop," as the case may be, arranged thus:

B. S. S. & D. CO. ENGINEERING DEPARTMENT.

FOUNDRY ORDER.

ORDER NO.	DATE. 189	DRAUGHTSMAN.
Countersigned by	Examined by	

These are manifolded in triplicate, and can be made out by any draughtsman to whom the job is delegated, but must be signed by the chief engineer, or in his absence, the chief draughtsman. The two copies are then sent down to the shop superintendent's office, who keeps one on file for his own reference and information, and immediately sends the other to the foreman of the department for which it is intended. In this way the shop superintendent retains control of his men in the different departments, and has knowledge of the orders that are issued. He alone is responsible for their proper execution, and undue interference of the draughtsman with the foremen or workmen is obviated. It is also the duty of the drawing office to order all raw material for new and special work that is not regularly kept in stock. This is done by blank as follows:

B. S. S. & D. CO. ENGINEERING DEPARTMENT.

DATE. 189	Please order the following for order No.
Ship	
Draughtsman	Countersigned Chief Engineer.

These are simply requisitions on the business office, and the copy goes to the storekeeper as a statement that the articles noted have been this day ordered. He will therefore be expecting them, and on their receipt will at once know for what order they are intended. His copy of the manifold reads: "The following material has this day been ordered for order No.—." Written orders are not issued from the drawing office to any other departments, except the pattern shop and foundry. Drawings and sketch sheets are issued to the other departments, as machine, smith, and erecting shop, etc. These pass through the hands of the shop superintendent, and in themselves constitute an order to make what they represent or call for, provided they are covered by the original general order from the business office and bear the same order number.

By means of these written orders to each department, each foreman knows definitely what work he has on hand, and all responsibility for errors or delinquencies is at once traceable to the culprit. The shop superintendent is also empowered to issue written orders to his foremen in all departments, for all work which does not require information from or the authority of the drawing office. For these he uses his own blanks—those of the drawing office being labeled "Engineering Department." It frequently happens that on large orders involving much detail, it is desirable to push the construction of parts as fast as they are determined upon before the completion of the general design. In these days of urgency and high pressure this is almost a necessary evil, but should be pursued with caution in the drawing office, lest difficulty be found in fitting the later part of the design to the earlier. Under this system of written orders the parts can be ordered in as fast as they are ready, even though the shop superintendent is as yet uninformed as to the balance of it, and does not know of what the complete order is to consist. When the drawing office work on the order is completed, an order list is made out and typewritten in duplicate. The order list enumerates in detail all the items making up the complete order, and is divided up into headings, such as (1) castings; (2) forgings; (3) miscellaneous; (4) special material ordered outside, and so on. For each item is given a reference number of the drawing or sketch sheet on which it is shown, and it is or should be shown thereon so fully and definitely that no further questions need be asked. This order list is essential—first, to inform the shop definitely of what the work consists; secondly, to refer the shop to a source of information concerning each and every item; thirdly, to form a shipping list so that in shipment nothing will be overlooked that should be sent; fourthly, to form a permanent record by which repairs may be readily identified, and from which future machines may be compiled or adapted. These order lists are press-copied in a book for the purpose.

Drawings.—The primary function of a shop drawing is to answer the shopman's questions, and, indeed, it may be said this is its only function. There are certain things connected with the material, form, dimensions, finishing, fitting, and erecting of a machine and each part of it, that each department needs to know. Sometimes in simple cases the various processes of pattern making, finishing, and erecting can be defined on one drawing, and in other cases separate drawings containing separate information for the different processes are demanded. It is important to have all the necessary information conveyed on a drawing in a direct and legible manner, and that the views be so chosen as to represent the object in the simplest way. Let the draughtsman, on beginning to make a shop drawing, say to himself, "Now, what does the fellow who is to make this want to know?" and then let him put down just that information and no more, but be sure and get it all on. Refrain from all superfluous lines and marks, and make the drawings so plain that "he who runs may read them." The mere ability to make lines and circles and projections is really the least important and least valuable part of a draughtsman's skill. Neatness and accuracy of drawing is desirable, but if it is obtained with the expenditure of an undue amount of time, and does not carry with it a practical knowledge of shop needs and shop processes, it ceases to be a virtue. The following set of rules for the drawing office have been found to be useful and to work well. They contain some points that a good draughtsman ought to know, but they are incorporated as reminders, and as being necessary to preserve uniformity of practice among changing draughtsmen.

DRAWING OFFICE RULES.

Shop Drawings.—1. All drawings shall be of the uniform size of 23 in. by 36 in. 2. All detail drawings for use in the shop shall consist of whole standard sheets, half standard sheets, and sketch sheets. Half sheets shall be 18 in. by 23 in., formed by ruling a line across the center of standard size sheets as filed, the blue prints only to be cut, and mounted, and varnished when necessary. 3. The sketch sheets shall be 8 in. by 11 in., and shall be used for all simple details, forgings, for bolt lists, and for all temporary work capable of being shown in this way. All standard machines shall be fully drawn out and blue printed. The sketch sheets shall be made with indelible pencil or copying ink and press-copied in the book for the purpose. The information on the sketch sheets shall be as complete as that specified for drawings.

Character of Shop Drawings.—4. A shop drawing is to be considered as an order or instructions to the shop, and not merely as a statement or illustration. For this purpose it must convey clearly all the information needed to make and finish the article. 5. Every dimension necessary to the execution of the work is to be clearly stated by figures on the drawing, so that no measurement need be taken in the shop by scale. All measurements to be given with reference to the base or starting point from which the work should be laid out. In comparatively simple constructions the several parts are to be shown together complete, although each part must be figured independently, and details supplied, if necessary, by sketch sheet. In more complicated forms each part should be detailed by itself and a general drawing made showing the thing complete. No details should be sent out without putting them together on a drawing, or taking them from a general drawing, so as to insure their fitness. Unnecessary duplication of views to be avoided, except in display or advertising drawings. 6. All figured dimensions on drawings to be plain, round vertical figures, not less than $\frac{1}{8}$ in. high, and formed by a line of uniform width, and sufficiently heavy to insure printing well. No thin, sloping, or doubtful figures or diagonal barred fractions will be tolerated. All figured dimensions below 3 ft. to be expressed in inches. 7. All center lines to be alternate dot and dash in fine black line. All dimension lines to be in continuous red lines with a central space for the figure, and of such strength as to show on blue print more faintly than lines of drawing. Lines of drawing to be bold and clearly defined in proportion to the scale, and to be shade lined by making the right hand and bottom lines heavier. No ornamental shading or other "frills" allowed on shop drawings.

Title.—8. Every drawing, whether whole or half sheet, shall have the title, date, scale, and number of the sheet placed in lower right hand corner. One man will be detailed for this duty, to secure uniformity. 9. The name of the drawing, as given in the title, is invariably to consist of two divisions in one line, separated by a hyphen. The first division is to state the general name of the thing or machine and the second division is to clearly designate the part or parts represented—or if a general view, should so state. The wording of the titles should be submitted to the chief engineer or head draughtsman for approval.

Drawing Symbols.—10. Detail shop drawings should state: (*a*) The pattern number of every casting in plain figures of larger size than the dimension figures. (*b*) The number of each piece required for one set. This should be written in one word—not figures—and followed by symbol of material. (*c*) The material of which the parts so ordered are made, using symbols as follows: C.I., cast iron; W.I., wrought iron; C.S., cast steel; M.S., machinery steel; H.S., hammered steel; Bs., brass; Bz., bronze; Bbt., babbitt; V.F., vulcanized fiber; C.R.S., cold rolled steel. Other materials, write full name. (*d*) The kind of finish on each of the different parts will be indicated by a letter preceding the figured dimensions as follows: F. means "finish," and indicates that the surfaces to which it applies are to be machined or dressed in suitable manner to size stated. F.B. means "finished bright," or polished. G.F. means "grinding finish," and indicates that the only finish to be allowed is that necessary for grinding. When no letter precedes the figured dimension it is understood that the part is to be left black or rough. In cases where finish might be presumed but not required, follow the figured dimension by the word "cast," if a casting, and "rough," if a forging. (*e*) A reference list of sketch sheets that may be used for detail illustrations.

Sketch Books.—11. Each draughtsman will be supplied with a sketch book by the company, and in which he shall make all his notes, calculations and data referring to his work, and under no circumstances shall original work be done on loose sheets and transcribed into these books. No effort should be made at neatness or nicety in these books, but each entry should invariably be commenced with the name of the thing and the date, and full notes made of data on which the calculations were based, and the results obtained clearly stated. These books are to be the property of the company.

Index for Drawings.—12. An index book for drawings will be kept in the drawing office by the clerk. This book will be divided into as many divisions as

* Presented at the Montreal meeting, June, 1894, of the American Society of Mechanical Engineers.

there are drawers, with provision for indexing 100 drawings in each drawer. The names of the drawings will be added to the various divisions according to their classification. The system of numbering shall be as follows: 13. Each drawer shall be numbered consecutively, and shall contain drawings devoted to a certain class of work, which shall be indicated on the drawer label. The drawing number shall consist of two or more digits with a decimal point between them. The whole number shall indicate the number of the drawer, and the figures after the decimal point shall indicate the serial number of the drawing in that drawer.

For example: Drawing No. 5·16 is the 16th sheet in Drawer No. 5, and Drawing No. 75·96 is the 96th sheet in Drawer No. 75. Not more than ninety-nine drawings shall be put in one drawer, except in exceptional cases. 14. Sketch sheets will bear the number of the letter and page of the letter book, preceded by the letter S, to distinguish them from drawings, and will be indexed in their own impression book, but not in the drawing index book. They will be referred to on general drawing of which they are details, and will also bear the number of such drawing. 15. When making a new drawing the draughtsman will apply to the clerk for a number, and will be allotted the first unappropriated number in the division to which the drawing will belong. 16. On completion of every drawing or sketch sheet it must be examined and initialed by the engineer before being issued, and the following entries made in books kept for the purpose: A. Record of blue prints and sketch sheets issued to shop, giving date, number and title. B. Drawing index—Record in day book the number, title and subtitle, draughtsman and date. C. Pattern index—Record in day book the number, classification and correct name of patterns, with remarks and date. Each draughtsman will see that these entries are properly made.

Patterns.—17. All patterns shall be numbered with the number of the drawing from which they are first made, followed by a letter indicating its serial on that drawing. For example, if four patterns are shown in detail on drawing No. 36·50, the patterns shall be numbered 36·50A, 36·50B 36·50C, 36·50D. When existing patterns are utilized in a new design or machine, their original number is to be noted on the drawing on which they are shown in their new employment. 18. Upon receiving formal notice from the pattern shop that patterns are ready for inspection, the draughtsman connected with the order shall examine same and issue foundry order for the casting. The date of inspection and name of inspector shall be entered upon the pattern maker's report at the time of making such inspection.

The sketch sheets referred to in these rules are 8 in. by 11 in. in size. They are of stiff cardboard, and the heading is printed in copying ink. The sketch is made with an aniline copying pencil, the "Eagle No. 2" in wood being used. They are press-copied in books for the purpose, and several books are used for different classifications of work. The books are of slightly heavier tissue paper than is commonly used for correspondence, and have 500 leaves each, numbered consecutively throughout the series, so that the number of a sketch sheet is never duplicated. In this system there are six books for copying sketch sheets, representing as many classes of work, and these divisions will readily suggest themselves as required for any particular case. The use of these sketch sheets is especially for work which does not require to be often duplicated, and for giving quick dispatch to emergency work. A freehand sketch can be made, copied, and issued in this way in ten minutes, while the regular process of drawing, tracing, blue printing, and waiting for the latter to dry, or the sun to shine, may consume hours. They have the additional advantage of being more convenient to handle and file away in the shop than blue prints, and save multiplications of tracings and consequent drawer space. The copies being in book form, cannot be lost and are easily indexed and consulted. Sketch sheets are convenient for rapid detailing of forging and small parts, and such parts need, therefore, to be merely indicated on the general or erecting plan, and reference numbers given of the sketch sheets. The sketch sheets will also all appear as items in the order list. In addition to the stiff card sketch sheet, it is convenient to have a "Drawing Office Memorandum" blank. This is a copying ink heading printed on a sheet of letter paper, and is used for order lists and all sketch matter sent abroad from the drawing office. After copying, the sketch sheet, if for permanent use, is sized with a mucilage composed of gum tragacanth and water, and then varnished with white shellac and alcohol. The sizing is to keep the lines of the sketch from running while varnishing.

Two necessary articles of office furniture are the drawing table and the blue print frame. So many excellent forms of these have been devised that it seems hardly necessary to refer to them in this connection, but some time hereafter occasion will be taken to describe types which have the merit of cheapness and effectiveness. It is our practice not to finish original drawings, but to trace from them on tracing cloth. These tracings are used only to print from and are filed away in a fire-proof vault. Two prints are made of each tracing as soon as finished, one for the shop—or more if necessary—and one to file away in the drawers of the office. These drawers are 24in. × 38in. × 2in., and are each calculated to hold a maximum of 100 prints. In this way the tracings are preserved from risk of fire and loss and from the wear of frequent handling. As a rule each draughtsman makes his own tracings, and only skilled draughtsmen are employed. The writer does not advocate the employment of cheap draughtsmen to trace shop drawings from the originals of the designer. If this is done, the designer must finish his original to entire completeness before turning it over to the tracer, thus consuming additional time and running more risk of errors and omissions than if he traced it himself. A skilled draughtsman will merely block out his entire work on the original and give his whole thought to the perfection of his design. In the tracing he can rearrange his drawing if necessary, and the time occupied in tracing is usually much less than that employed in working out and perfecting the design, and a draughtsman worth 120 dols. per month will usually trace twice as fast as one worth 60 dols., and do it better. The titles on drawings are mainly done by rubber stamps giving the name of the company, the number of drawing, and having spaces for the insertion of name, date, and scale. Some experimenting was done to find a suitable stamp ink for tracing cloth. Printers' ink was tried; but it rubs off, and does not dry satisfactorily. A special lithographic ink is used, which is similar to printers' ink, but with the addition of a drier. It is applied to the stamp by a composition roller, in a similar manner to printers' ink, and gives a black impression which blue prints well. The number stamp has movable type. As a rule, it pays to employ only high-class labor in the drawing office. A draughtsman puts his own impress on his work, his individuality goes into it, even if closely supervised, and it is upon the perfection of detail that the success or failure of a new design mainly depends; it is important that the draughtsman intrusted with it shall have the necessary skill and ability. We have appliances for testing the efficiency of almost every known mechanism; but who can measure the efficiency of the draughtsman? We appreciate the economic value of good steam distribution and the like; but too often is the efficiency of the draughtsman neglected, and thousands of dollars spent in the construction of work which would have yielded much better results if a little more brains had been used in its design.

In conclusion, the writer would say: Do not have so much system that it is difficult to work to or burdensome to carry out. A few simple rules faithfully adhered to are better than the most elaborate system which is loosely or imperfectly carried out. The object of a system is to define the duties of each man and to fix the responsibility of dereliction of duty.

THE USES OF PHOTOGRAPHY IN MEDICINE.*

By ANDREW PRINGLE.

IN order not to spoil a good cause by claiming too much, I will content myself by asserting that no department of science has received more benefit from photography than has the art of healing. And it must be evident to every one that, for such work as recording the state of a patient from hour to hour, the fluctuations of a disease from day to day, or its gradual progress after the time of operation until recovery or the reverse, photography stands pre-eminent. As photographs of malignant disease are not pleasant things to look upon, I must content myself with bringing before you only a few very simple cases, but these will be quite sufficient to prove to you the extent to which, in medicine, the camera may act as a recording agent.

The lecturer then showed a number of lantern slides, pointing out their salient features as each was projected upon the screen. The first was the photograph of a boy afflicted with atrophy of the facial muscles. The next was a most interesting case of lupus of the hand, both before and after treatment by Koch's tuberculin. The lecturer here took the opportunity of pointing out how important it was in medical photography that the work should be done with the utmost care. In the case which he had just shown them, he himself, by an error of judgment, made a photograph give an altogether false impression. By giving too short an exposure, he made a patient who had been operated upon look far worse than she did before the operation, although, as a matter of fact, she had benefited by the treatment considerably. Mr. Pringle then explained the apparatus which he had found convenient for taking pictures of hospital and other patients, the instrument consisting of a camera mounted upon which was a finder of the same focal length as the lens fixed upon the camera below it. He intended, however, to lay chief stress upon what is known as photomicrography, and he would regard it more particularly in the light of an educational agent, and as used for teaching purposes. At schools of medicine and the like, where a large number of students are engaged in studies which are only made possible by the use of the microscope, it has been customary to cut a large number of sections from a piece of tissue, and to examine such sections, each under a different microscope, for the microscope is an instrument which permits of only one observer at a time.

Now, no two sections can be identical, and more often than not critical points, upon a right appreciation of which the subject matter of a lecture may altogether depend, are absent in some; but, if the demonstrator be provided with an optical lantern, and he is able to exhibit the photograph of a chosen section of the tissue under consideration, he can point out its salient features to all the students at the same moment, and no one can complain that he is not as well off as his neighbor. Mr. Pringle then proceeded to give evidence of the advantages which he claimed for lantern demonstration by exhibiting a large number of photographs on the screen. First he showed some photographic preparations, which were exceptionally fine, among which were a slide of "voluntary muscle" by himself, an example of ossifying cartilage (Klein), a complete section of the human eye, showing very beautifully the cornea, crystalline lens, the retina, and the optic nerve, and a fine example by Bousfield of Cortis' organ of the inner ear.

Next came some very beautifully executed photomicrographs of bacteria, including a "plate culture" of Proteus (Klein); two examples, showing bacteria in the dentile tubules of decaying teeth (Sewill), and a splendid example of anthrax bacilli in mesentery by Pasteur.

The consideration of preparations of great rarity came next, and as an example of these were shown that happily rare organism known as Filaria sanguinis hominus, a parasitic, wormlike creature, which, as its name implies, finds its habitat in human blood, but more particularly in the blood of negroes. Three slides referring to this interesting organism came under review by the lecturer, showing—(1) its ordinary appearance; (2) the sheath of the parasite; and (3) the number of parasites in the restricted field of the microscope; and the comparative size of F. nocturna (so named because it is only found in the night time) and F. perstans.

Next came a few words about objects which exhibited unusual difficulties in preparation, and as an example of these the lecturer exhibited a photograph of cholera bacilli, with their flagella plainly visible. These flagella are most difficult to see, even to a trained microscopist, and it might easily have been asserted that a man had fancied he had seen them, and that they did not really exist; but here was the photographic record which cleared up the doubt conclusively. Another example of the Bacillus termo, also showing flagella, was thrown upon the screen, and the lecturer explained that in this case the hairlike flagella had been carefully measured by Dr. Dallinger, who had found that they had a width of only the $\frac{1}{200000}$ of an inch. It was quite a triumph to reproduce these microscopic objects photographically.

The lecturer next dealt with examples which, by speedy and convincing comparison, would serve to set at rest questions in which opinion was divided. He showed two preparations of nerve cells, the one being properly "fixed," and the other being faulty in that respect, giving rise to appearances which might lead a student into error. Examples were also shown of certain newly discovered bodies which were found in cancer, the real and the spurious being readily distinguished by the comparative method.

The next slides shown were of very great beauty. They were "culture plates," which had been exposed for five minutes, the one in the comparatively pure air of Wandsworth Common, and the other in Oxford Street. The first named showed only a very few traces of bacteria, but the second was crowded with thick colonies of them. The advantage of at once obtaining photographic records of preparations subject to such quick growth and other changes as these culture plates are, was fully pointed out by the lecturer. In a demonstration of some particular points where only exceptional microscopic preparations are available, the lecturer showed as examples—(1) the position of the bacillus of leprosy in regard to cells and nuclei, and (2) the position of the organisms in certain vessels in a rare form of skin disease. In this last demonstration three slides were exhibited of the same section, each under a different amount of magnification. In the first, taken with a low power objective, the organisms were hardly visible; in the second they were plainly seen; and in the third, where the magnification was 1,000 diameters, they came forth in all their hideous detail. Some specimens of lantern slides, colored by the Lumiere method, elicited the fact that, although the original preparation was well imitated so far as the staining was concerned, the advantage gained was more than counterbalanced by loss of crispness, and the lecturer expressed a doubt whether, under such conditions, there was any gain at all.

In order to convey an idea to his audience of the actual magnitude of some of these microscopic objects, the lecturer threw upon the screen photographs of yeast cells, in conjunction with a network of squares, the sides of which measured only $\frac{1}{2500}$ of an inch. In the case of some other organisms, squares measuring $\frac{1}{7500}$ of an inch were employed.

In conclusion, the lecturer impressed upon his audience the desirability of photographers assisting, by every means in their power, a profession like that of medicine, which, above all others, can claim to have rendered the highest service to humanity.

In moving a vote of thanks to the lecturer, the president expressed regret that more medical men were not present to benefit by this most important paper.

* A recent address before the Photographic Convention of the United Kingdom.—British Journal of Photography.

THE HAVEMEYERS.

LIKE the Astors, the Havemeyer family is of German origin, although they have been identified with New York and with the industry with which their name is so distinctly associated in the public mind ever since the early years of the present century. Henry D. Havemeyer, who is the active front of the great sugar trust, and who during the past few days has been so conspicuous in the Washington investigation, is the grandson of Frederick Havemeyer, who, with his brother, William F., came to this country in 1802 from Germany. These two original Havemeyers began the sugar refining business as soon as they reached this country, and the refinery, as well as their residence, was in this city. It was here that Henry Havemeyer's father, who was then Frederick G. Havemeyer, Jr., was born in 1807. At the time Henry's father was old enough to begin to be interested in the mysteries of the sugar refining business, the establishment was a very modest affair.

The two brothers who came originally to seek their fortunes in this country had learned the sugar making business in London, and even when Henry's father began work in the concern here it was called the Havemeyer bakery, and Henry's grandmother, who was a native of Little Britain, Orange County, N. Y., used to boast in her old age that she used to help in the little factory when her son Frederick, Henry's father, first came into the business. It was considered a very creditable day's work then when they baked an entire hogshead of sugar in a day. The building in which the business was done was a little concern only 25×40. The yearly production was about 1,000,000 pounds of sugar. This is in striking contrast with the enormous Williamsburg plant, covering acres of ground, and the output of the sugar trust's work—and the Havemeyers virtually are the trust—is very many times more in a day than was the entire yearly production. Yet, even in those days, the Havemeyers were, as they are now, at the head of the sugar refining industry in the United States.

When the two original Havemeyer brothers retired they were succeeded by their two sons, William F., who was mayor of New York for several terms, and Frederick C., the father of Theodore and Henry, who are now at the head of the trust. It was Frederick C. who did the most to build the business and keep it at its original place at the head of the sugar refining industry of the country. It was said of Frederick that he knew more about sugar refining than any man in the world. He learned the business both theoretically and practically. He was rather a scholarly man. Joe Nelson, famous in early days as the blind teacher, was his first tutor, and, after leaving him, he went to Columbia College, where he was noted as being a diligent student and having a retentive memory.

Frederick died in 1891, leaving $3,000,000 and four sons, Frederick, Theodore, Thomas and Henry, the last named being the present financial head and general manager of the trust. Theodore, who is the president and nominal head of the trust, is referred to as

the refiner. He is also the Austrian consul in this city, and gives little attention compared with Henry to the sugar business.

The sugar trust, which monopolizes the entire sugar refining business of the United States, was formed in 1887. So far as the production of refined sugar in the United States goes, it actually has no competitor, and, as Henry testified with so much frankness in Washington, can and does regulate prices in this country at its pleasure. From foreign competition it is protected by a tariff of $\frac{1}{2}$ a cent per pound on refined sugar. To this must be added about $\frac{1}{8}$ of a cent per pound of natural protection. The real protection which the trust enjoys is, therefore, $\frac{5}{8}$ of a cent per pound. This puts it in the power of the trust to raise the price here over $\frac{1}{8}$ of a cent per pound above the foreign price before foreign sugar can be brought in. It was not until the Claus Spreckels refinery in Philadelphia was admitted to the combination that the trust was fully formed and its arrangements for the absolute control of the sugar refineries of the country were completed.

When that arrangement was made, the trust consisted, as it does to-day, of what formerly had been the seventeen distinct firms. These were the Havemeyer & Elder Company, the Brooklyn Sugar Company, Decastro Donner, the Havemeyer Company, of Brooklyn, the Havemeyer Company, F. O. Matthiesen & Co., of Jersey City, the Standard Company, the Boston Company and the Continental Company, of Boston, Forest City, of Portland, St. Louis Company, of St. Louis, the Louisiana and Planters' Company, of New Orleans, the Franklin, E. C. Knight, Spreckels and Delaware Company, of Philadelphia, and the Baltimore Company, of Baltimore. The total daily capacity of these is about 55,000 barrels. The only refineries in the country are the Revere Company, of Boston, with a capacity of 1,000 barrels; the California Company of Claus Spreckels, 1,000 barrels; and the American Refinery of Havemeyer & Elder, also of California, with a capacity of 2,000. The Revere Refinery is owned by Nash, Spaulding & Co., who are large owners in the trust, and who work in harmony with them.

A long time ago Havemeyer, Elder and Spreckels formed an auxiliary company, to which they leased their California plants, making them also practically a part of the trust. The total capitalization of the trust is $85,000,000, made up of $75,000,000 capital stock and $10,000,000 bonds. The actual value of the plants is estimated at $40,000,000. The annual profits of the trust on refining alone are in the neighborhood of $35,000,000, or about 73 per cent. on the actual investment and 34 per cent. on the present capital.

Although Henry is the actual manager of this concern, he is neither so wealthy nor conspicuous in New York as is his brother Theodore. Henry, when in the city, is at his desk every morning at the headquarters on Wall Street, and rarely goes away before 5 o'clock. In his business dealings he is somewhat brusque and very reticent as to the sugar business, except when before a congressional committee, where his cheerful frankness in admitting that the trust was a monopoly formed to raise the price of sugar left nothing to be desired. In his social relations he is particularly amiable and inclined to a liberal hospitality. His city home is one of the most luxuriously furnished in the city, but the home in which he takes the most pride is the beautiful place at Stamford, Conn. Here he lives the greater part of the year. It was four years ago that the Connecticut house was finished, and since then he has spent many thousands of dollars in beautifying the grounds. The grounds are about ninety acres in extent, and for a century and a quarter before he got possession of them were held by the Palmer and Quintard families. Of the ninety acres, fifty are lawn, the remaining forty being given to pasture. Like his brother Theodore, he is fond of fancy stock.

Theodore, the wealthiest of all the family and a figure much more familiar to New Yorkers than his brother Henry, was married about thirty years ago to the daughter of the Chevalier De Loosey, the Austrian consul-general to New York, and on the death of his father-in-law succeeded him in office. He has nine children, the two eldest of whom are married. The oldest son, Charles, is employed in his father's office. The others range in age from eight to twenty years. Theodore's house is an unpretentious but solid mansion at the corner of Thirty-eighth Street and Madison Avenue.

Mr. Havemeyer is quiet in his tastes, addicted to playing on the violin. But the most expensive indulgence he permits himself, and the one in which he takes the most pride and enjoyment, is his princely estate at Mahwah, N. J. He seldom lets a week go by without a visit to his Mountainside farm. The property is nearly 1,000 acres, and is thirty-two miles from New York on the Erie road. It was purchased twelve years ago. It lies on the western slope of the Ramapo Mountains and contains some of the most fertile lands of the Ramapo Valley, with the exception of a small portion on the eastern side, which is hilly and devoted to pasture land. It cost about $100,000, and to-day, with the improvements he has put on it, it is worth many times that sum. There is scarcely a branch of fancy stock raising, with the exception of the breeding of horses, that is not carried on. It is estimated that he has over $200,000 worth of valuable beasts on his farm. The farm house, built of brick and stone, cost $150,000. Here Mr. Havemeyer and his family spend about six weeks every fall, when his guests are numbered by the score. It is an open house for all of the Havemeyer friends on these occasions. He sells about 2,000 chickens a year in New York.—*Times-Democrat.*

CHICAGO IN 1830.

CHICAGO.

CHICAGO is regarded by many people as being the most representative city in America. New York, Boston, Philadelphia, all have histories crowded with the events of two hundred and fifty years or more, but only sixty-four years ago Chicago existed as a group of small low wooden buildings clustered around Fort Dearborn. From 1830, when thirty-two voters went to the polls, the population has risen to 1,208,669 in 1890, and the second city of the Union has been evolved from the embryo settlement shown in our first illustration. Prior to 1830 there was no town. The sale of lots was made by the Canal Commissioners appointed by the Legislature of 1829. Some of the prices realized at the sale seem ridiculously low when compared with the enormous prices paid for even single lots in the Chicago of to-day. Part of the property was sold as low as $1.25 an acre. After this sale of the

STATE STREET, CHICAGO, 1894

lots the boom began, which has not, to all appearances, ceased as yet. The act creating Cook County became a law January 15, 1831, and the county was organized in March of the same year. The first post office was established in 1831. Two taverns received town licenses, and all the charges were fixed by law, dinner being 37½ cents. A bridge was built over the South Branch, between Lake and Randolph Streets. The white citizens contributed $286.20, while the Pottawatomies were mulcted in the sum of $200. This first bridge across the Chicago River was only taken down in 1840. The first drawbridge was thrown across the river at Dearborn Street in 1834, and then began that merry war between the north and south sides which has not ceased at the present day. The Internal Improvement act was passed in 1837, a period of wild inflation, in which millions were wasted. Soon the times became hard, and years of struggle followed.

Probably no city in the world has been visited by such a disastrous series of fires as Chicago, and no reference to the history of the city, no matter how short, would be complete without some mention of the terrible fires which have scourged the city. The long series of fires was inaugurated by a fire in 1834 in which the damage was $1,200. On September 19, 1835, the first volunteer fire department was formed. The terrible fire of 1871, the worst fire of which we have any record, not excepting the London fire of 1666, entailed a loss of $200,000,000. The fire started at what is now 137 De Koven Street, and raged terribly for two days, burning from Fullerton on the north to Twelfth Street on the south and from the Lake as far as Halsted Street. The fire began Sunday, October 7, 1871. Only last year a series of fires began which have succeeded in reducing the magnificent Fair buildings to a mass of ruins. Last week two fires destroyed over $2,000,000 worth of property. The fires, bad in themselves, have, however, done much to increase the beauty of the streets, for the city which rose like the phœnix from the ashes of 1871 was entirely different from the city which was destroyed.

Our other illustration is a view of the State Street of to-day, one of the busiest streets of the great inland metropolis. At intervals rise the many-storied office buildings which are not inaptly christened "sky-scrapers." All day long the clang of the cable car gong is heard, and even in the evening the streets are crowded with pedestrians. Looking upon this busy scene, it is not difficult to believe that we are in the heart of a great city whose manufactures and wholesale trade have risen from $20,000,000 in 1850 to $1,409,000,000 in 1891. For our illustrations we are indebted to the St. James's Budget.

CAVE EXPLORERS BURIED FOR EIGHT DAYS.

NOT long ago the German journals gave an account of the truly lamentable expedition of a party of explorers who became prisoners underground through the rising of the waters of a stream that cut off their retreat.

The following are some authentic data in regard to this adventure, which, after threatening to be tragic, fortunately terminated in the delivery of the unfortunates who were in jeopardy.

The terrible eight days that six members of the Society of Cavern Explorers, of Gratz, and a sixteen-year-old collegian passed in the Luegloch, near Semriach, were due to an accident that the party met with through culpable thoughtlessness.

The sole motive of the enterprise undertaken was to get ahead of another society that explores caves, and with some little scientific spirit, too. Despite the warning of the curate of Semriach, Mr. Gasparikz, who knew all the dangers of the Luegloch, the seven imprudent explorers entered the latter on the 29th of April without taking even the most elementary precautions.

The ravine which leads into the cavern is traversed by the brook of Lueg, a thin stream of water ordinarily, but which increases formidably in rainy weather in consequence of the affluence of all the waters of the vicinity.

The stream enters the cavern at the point, A (Fig. 2), and at a few steps further along the hole that it has formed in the rock as a passage for itself becomes so narrow that it is impossible for one to advance without stooping or even crawling. Twenty steps further on this very narrow passage widens out into a sort of hall or antechamber, B. If one continues to follow the bed of the stream for thirty feet more, he reaches a passage, *d*, that has a slight slope and that it is necessary to traverse by creeping. This passage debouches in the Faeltzmann chamber, C, and then in a series of other chambers which join one another in a straight line. At the entrance of this passage the stream disappears in an excavation leading toward *c*, and the arrangement of which had not as yet been explored.

The seven explorers had got as far as the Faetzmannshoehle. Unfortunately for them, not only had the stream become swollen, but had also carried along some trunks of trees and some branches, the accumulation of which stopped up the channel of discharge, *c*, and caused a local inundation. So when the seven imprudent explorers, warned by the water that was entering the Faeltzmannshoehle, were desirous of returning, the passage that they had traversed a short time before was no longer practicable and their retreat was cut off.

The unfortunates were obliged to remain buried thus for eight days and a half. Through tin boxes filled with food that were thrown at hazard into the stream

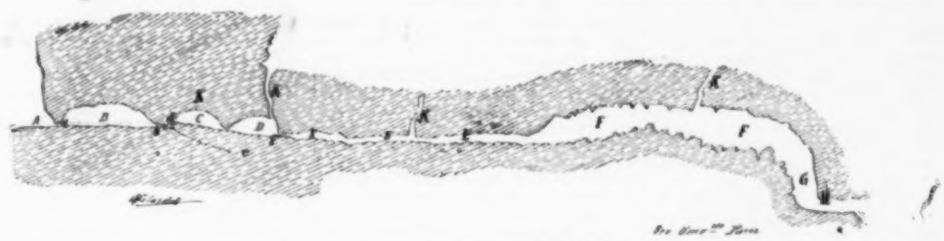


FIG. 2.—SECTION OF THE CAVE.

A, entrance; B, first chamber; C, Foltzmann chamber; D, Oswald chamber; E, gallery of stalactites; F, stalactite chamber; G, Tartarus; *a*, *b*, passageways; *c*, drainway; *d*, passageway; K, unexplored parts.

and that the latter carried to them, they fortunately received enough sustenance to prevent them from dying of hunger while awaiting the hour of delivery, which was long. The work of rescue, however, was particularly difficult, and it was not till after the arrival of a detachment of military pioneers, sent by order of the Emperor, that it could be pursued methodically and with any rapidity.

In order to widen the passage, it was necessary to employ dynamite. Thanks to the rapidity of the rescuers, it finally became possible at 3 o'clock in the afternoon of May 7 to enter into communication with the unfortunates, and soon afterward the student, Rodolph Haidt, the prisoner who had suffered the most from his eight days' captivity, was brought out into the open air.

When they saw that their retreat was cut off by the water, the explorers penetrated the interior of the mountain to a distance of about 2,000 feet. But here they found themselves arrested by a perpendicular fissure. Fatigue, moreover, had got the better of their first apprehensions, and they slept soundly during the first night. It was not till the next day that they realized the horror of the situation, and one can easily imagine what their existence must have been up to the moment when the explosion of the first dynamite cartridge apprised them of the approach of the rescuers. It is to be hoped that this adventure may serve as a lesson to those too numerous novices who embark upon such excursions without any precaution and often despite the prudential advice that is given them.—*Revue Universelle*.

[Continued from SUPPLEMENT, No. 971, page 15536.]

RAIN MAKING.*

By FERNANDO SANFORD, Professor of Physics, Leland Stanford Junior University.

AITKEN found that dust particles of microscopic size were sufficient for the nuclei of condensation, and R. Von Helmholtz showed that condensation could take place upon particles so small that it took four days for them all to settle through still air to the lower side of a horizontal glass tube about one inch in diameter.

Aitken counted the number of these dust particles in different samples of air by first diluting the air with two hundred times its volume of air which had had its dust particles removed by being drawn through water and then saturating the air with water and cooling far below its dew point and counting the number of water drops falling upon a given area until all the dust particles were carried down. He found the number of dust particles to vary from 34,000 per cubic inch in pure air taken from the top of Ben Nevis to 88,346,000 per cubic inch in air taken from a room near the ceiling, and nearly 500,000,000 per cubic inch in the flame of a Bunsen burner.

The number of these dust particles in the air determines the character of the precipitation. If the dust particles are very numerous, each one becomes a nucleus for the condensation of water vapor, but only a small quantity of water will be condensed upon each one; hence the formation of the fine drops which constitute fog. If the number is smaller, as it is likely to be at a greater distance above the earth, each nucleus may receive a larger quantity of water, and a cloud may be formed. If they are few, or if the total amount of condensation is great, the drops which are formed become heavy enough to fall to the ground and rain is produced. If the nuclei are very few, rain may fall from an almost cloudless sky.

It is well known that as we ascend above the earth the temperature falls about one degree Fahrenheit for three hundred feet; consequently, while the air at the surface of the earth may be far above the dew point, the air at a few thousand feet above the earth may be cooled below the dew point. The height of the clouds always indicates the distance above the earth at which the air is cold enough for condensation to begin. The clouds, being made up of these little dust particles surrounded by water, are heavier than the air, and are slowly settling toward the earth, but as fast as the little drops settle into the warmer air, the rate of evaporation from their surface is increased, and before they have settled far the water has been evaporated off. Hence, at a given time, over an area of uniform temperature, the lower surfaces of the clouds are all at nearly the same distance above the earth.

How, then, shall rain be produced in the great unbounded atmosphere? There are but two ways. Either the total quantity of vapor in the atmosphere must be increased or the temperature of the air must be diminished. It is probably safe to assume that there are, under all ordinary circumstances, a sufficient number of dust particles in the air to form the nuclei for condensation, so that no artificial provision need be made for these.

So far as I am aware, no enterprising rainmaker has yet proposed a method of increasing the total moisture of the air to any appreciable extent, though some of them have attempted this on the small scale, probably in the vain hope that if they touched the button, nature would do the rest. This, by the way, has been the one claim upon which all these pretenders have based their arguments. They have steadfastly and with unanimity asserted that if a little condensation could be started in one place, it would at once spread out in all directions, like the benign influence of the little homeopathic pill. How a rainfall started in this way is ever to stop as long as any aqueous vapor remains in the air, they have not condescended to tell us. This question has not, so far as I know, ever been raised by the results of their incantations.

As a matter of fact, every drop of water taken from the air decreases the number of vapor molecules remaining, and, consequently, lowers the temperature of the dew point. Likewise, every free molecule which is brought to rest by striking against a solid body gives up its energy of motion to that body and increases the total energy of its molecular vibration, so that a body upon which water molecules are condensing is having its temperature continually raised, and it must be continually giving off heat to surrounding bodies, or it will soon be warmed above the temperature of condensation. In the case of the dust particles of the atmosphere, they must give off this acquired heat to the molecules of the air which come in contact with them; hence the condensation of moisture from the air raises the temperature of the air. There are, accordingly, two reasons why heat must be continually taken from the air in order to keep up condensation. The temperature of the dew point is being continually lowered by the loss of vapor molecules, and the temperature of the air is being continually raised by the amount of heat which these molecules lose when their motion is stopped.

In the formation of rain by natural causes this continuous decrease of temperature is provided by ascending currents of air which carry the water molecules upward into continually cooler and cooler regions. These ascending currents of air may be caused by mountain ranges, which deflect upward the winds that blow against them, by the expansion of the air over a heated area of the earth's surface, and possibly by other agencies not yet understood. In the case of our California storms, these ascending currents are usually persistent for several days, frequently moving across the whole continent. They are marked upon our weather maps as areas of low barometric pressure. Whenever there is an area over which the barometric pressure is less than the normal, it is an indication of

* A lecture given before the students of the Leland Stanford Junior University, March 6, 1894.—*Popular Science Monthly*.

FIG. 1.—RESCUE OF THE EXPLORERS OF THE LUEGLOCH CAVE.

an ascending current of air, and wherever there is an ascending current of air there is a probability of rainfall, though, if the air be very dry, it may not be carried to a sufficient height to be cooled below its dew point.

On the other hand, wherever there is an area of increased barometric pressure, or of high barometer, it is an indication that there is a descending current of air over that area; and since air which is settling toward the earth is continually having its temperature raised, no precipitation of moisture will occur over an area of high barometer.

The simultaneous weather observations conducted by the government enable us to locate these regions of ascending and descending currents, and long observation has enabled us to predict their probable path across the continent, and it is upon these data that the weather officers base their predictions of future weather. Since these areas regularly travel from west to east, we in California receive much shorter notice of their coming than do the people farther east, and the weather predictions issued from our local bureau are proportionally more liable to error than are those issued from stations beyond the mountains.

And now as to the possibility of producing rain by artificial means. It is never safe to say what things are possible and what things are impossible to man. What the future may bring forth no one can tell. At the present time, however, there is no evidence to show that even the smallest local shower has been produced artificially. Further than that, it is safe to say that no method of producing artificial rain has yet been publicly proposed which suggests to one familiar with the scientific principles involved even a possibility of success. That such attempts have received the official recognition and the financial support of Congress is only another evidence of the gross ignorance of scientific principles which is prevalent among our so-called educated men. That some of the men who advocate these wild schemes are honest in their motives cannot be questioned, but that all the professional rainmakers are conscienceless fakirs is scarcely more questionable. That many of them are able to submit testimony as to the efficacy of their system is equally true of every patent medicine fraud and electric healing quack who has ever swindled an ignorant public. As an illustration of the value of testimony of this kind, let me give you a local example.

I will read from the San Francisco *Examiner* of February 2, 1894:

He Produces Rain at Will.

HIGHLY SUCCESSFUL EXPERIMENTS OF THE VISALIA RAINMAKER—HEAVY SHOWERS AT PIXLEY.

HE SELECTS THE DRIEST SECTION OF FRESNO COUNTY, WHERE RAIN SELDOM FALLS, AND BY THE USE OF CHEMICALS CAUSES LOCAL DOWNPOURS ON TWO SUCCESSIVE DAYS—MANY OTHER TESTS MADE.

Visalia, February 1.

A week ago Wednesday Frank Baker, of Visalia, an amateur rainmaker, went to Pixley for the purpose of producing rain. Before he left he informed the *Examiner* correspondent that he intended to produce rain within seven days, and he kept his word. On Tuesday and Wednesday a local rainstorm occurred in the vicinity of Pixley amounting to 0·35 to 0·45 of an inch.

Mr. Baker returned to this city this morning in jubilant spirits. He is now satisfied beyond a doubt that he can produce rain by means of his appliance. He proposes to visit Pixley every two weeks, and is sanguine that he will be successful in his experiments. During the months of April and May he proposes to put forth his best efforts in order to thoroughly drench the soil. The residents of Pixley are well pleased with Baker's experiments, and they propose to assist him in conducting his future operations.

THEY VOUCH FOR HIS EFFICIENCY.

He brought back with him the following letter:

"This is to certify that it rained 0·35 to 0·45 of an inch at Pixley on the 30th and 31st of January. We gentlemen here vouch for the truth of the same; that it is a local rain of fifteen to twenty miles in extent, and that it was brought about by the Baker process.

"J. J. Kelly.
"Charles S. Peck,
"W. M. Jackin,
"L. E. Smith,
"J. T. Austin,
"John W. Harper."

Now, it is not my purpose to impugn the veracity of the gentlemen whose names are signed to this certificate. I know none of the gentlemen. I do not question the only point in the statement to which the gentlemen could possibly subscribe of their own knowledge. You will observe that the certificate includes three separate statements: (1) That it rained in Pixley on the 30th and 31st of January; (2) that it was a local rain of fifteen to twenty miles in extent; (3) that it was brought about by the Baker process. Manifestly, the only one of these statements to which the gentlemen could have subscribed of their own knowledge is the first.

Fortunately for the settlement of questions of this character, we have the use of data collected by the Weather Bureau. When I read the above article I at once wrote to Mr. Pague for the maps issued by the Weather Bureau for January 28 to 31 inclusive. He kindly forwarded them to me, and the following data were compiled by me from them:

On the map of Sunday, January 28, 5 P. M., an area of low barometer is shown with its center west of Vancouver. The weather was reported cloudy and rainy north of the Oregon line. The weather forecast was "rain in northern California." Twelve hours later, Monday, January 29, at 5 A. M., the storm was central over northwestern Washington. I quote verbatim from the predictions printed upon the map: "The conditions this morning are favorable for rain over California from the Tehachapi Mountains northward by Tuesday morning, and possibly will extend southward Tuesday afternoon or night."

At 5 P. M of the same day the map shows a storm area extending from British Columbia to southeastern California, with its center near Keeler, about ninety miles east of Pixley. Here the storm center remained for thirty-six hours, while the storm was gradually breaking up over its northern part, as shown by the three following maps, and not until the map of Wednesday morning is there an indication of an eastward movement of the storm, while as late as 5 P. M. of Wednesday, January 31, rain was reported at Keeler. During Monday and Tuesday light rains were reported over nearly all parts of the State, and on Tuesday it rained at Pixley.

From these data we see that the local rainfall produced by the Baker process at Pixley was part of a storm which extended over a large part of British Columbia, over Washington, Oregon, California, Utah, Nevada, and Arizona, and which had its center for thirty-six hours within ninety miles of Pixley, and that the weather forecasts sent out from San Francisco on Monday morning at 5 o'clock predicted rain for the region about Pixley for Tuesday afternoon or night. As a matter of fact, it rained at Pixley on Tuesday night, as had been predicted by Mr. Pague thirty-six hours before.

I have referred to this special case, not because it differs in any essential particular from other well-authenticated cases, but because one typical example which any one can verify is worth a great amount of generalizing, and because this particular instance has been so prominently mentioned by the press of the State.

And now I wish to say a few words about the methods of some of the best known of the professional "rainmakers." For most of the following data I am indebted to a paper read by Prof. Alexander Macfarlane, of the University of Texas, before the Texas Academy of Science.

Powers.—In 1870 Mr. Edward Powers, of Delavan, Wis., published a collection of statistics in a volume entitled "War and the Weather." By means of these statistics he seeks to establish the remarkable fact that battles are followed by rain. He does not prove that battles are necessarily accompanied by rain, or that a day of battle is followed more quickly by rain than a day of no battle. Having, however, apparently convinced himself of the value of his argument, he at once adopted the universal American expedient of proving his claim, and petitioned Congress for an appropriation to make a suitable test. Two hundred siege guns which lie idle at the Rock Island arsenal were to be taken to a suitable locality in the West, and one hundred rounds to be fired from them in each of two tests. The estimated cost of the experiment was to be $161,000. He does not tell us how the molecular vibration caused by the sound and heat of the firing is to lessen the molecular vibration of the air and cause the vapor molecules to come to rest.

Probably the distinction between a scientist and a crank could not be shown more clearly than in a comparison of the methods of Aitken and Von Helmholtz with the methods of Powers. The former spent years working in private and at their own expense to find, if possible, some explanation of the mystery of condensation. The other wished an appropriation of one hundred and sixty thousand dollars from the government in order to test his visionary hypothesis.

Ruggles.—In 1880 Daniel Ruggles, of Fredericksburg, Va., patented a process for producing rain. The invention, as described by Mr. Ruggles, consists of "a balloon carrying torpedoes and cartridges charged with such explosives as nitroglycerin, dynamite, guncotton, gunpowder, or fulminates, and connecting the balloon with an electrical apparatus for exploding the cartridges."

This is another scheme for lowering the temperature of the air by heating it.

Dyrenforth.—It is probable that the name of Mr. Dyrenforth is better known in connection with attempts at artificial rainmaking than that of any other man. As a result of the agitation of Mr. Powers, Congress voted two thousand dollars to make a preliminary test, and the inquiry fell to the scientists connected with the Department of Agriculture. They reported that there was no foundation for the opinion that days of battle were followed by rain, any more than days of no battle. It was then that Mr. Dyrenforth came forward with Ruggles' plans and offered to make some tests. Through the influence of Senator Farwell, an additional appropriation of seven thousand dollars was placed at his disposal for a series of practical tests, which were made at Midland, Texas, in August, 1891. A further government appropriation was expended in tests at San Antonio, Texas, in November, 1892.

Mr. Dyrenforth's plan seems to have been to imitate as nearly as possible the conditions of a battle. His explosives were ranged in a line facing the advancing clouds. Shells were fired into the air at frequent intervals. Dr. Macfarlane states that the "general" and his lieutenant even wore cavalry boots.

In addition to these warlike demonstrations, cheap balloons containing hydrogen and oxygen mixed in the proper proportions for forming water were sent up, and the gases were exploded by means of a time fuse attached to the balloon.

At the time of making the San Antonio tests, November 25, 1892, the record of the weather office in San Antonio at 8 P. M. gave the temperature of the air at 72° F. and the temperature of the dew point as 61° F. Dr. Macfarlane makes the following calculations upon a cubic mile of the air under the above conditions: to cool down the cubic mile of air to the dew point would require the abstraction of as much heat as would raise eighty-eight thousand tons of water from the freezing to the boiling point. To cool it eleven degrees more would require the abstraction of the same quantity of heat again. This would cause the precipitation of twenty thousand tons of water, which spread over a square mile would give 1·4 pound per square foot or 0·27 of an inch of rain. The amount of heat which the twenty thousand tons of water vapor would give off to the particles upon which it would condense would raise a hundred thousand tons of water from the freezing to the boiling point, and this would also have to be taken from the air in order to allow the condensation to continue. According to this computation, enough heat would have to be extracted from the air to raise two hundred and seventy-six thousand tons of water from the freezing to the boiling point in order to produce a rainfall of about a quarter of an inch over an area of a square mile. This two hundred and seventy-six thousand tons of water would cover the same area to a depth of more than six inches. Accordingly, in order to produce a rainfall of a quarter of an inch under the conditions mentioned, enough heat would have to be taken from the air to heat a body of water covering the whole area to a depth of ninety feet through one degree Fahrenheit. To accomplish this purpose Mr. Dyrenforth proceeded to raise the temperature of the air still higher by means of heat-producing explosives.

Under these conditions eight balloons, a hundred and fifty shells, and four thousand pounds of roselite were fired off. No rain appeared. One balloon exploded within a black rain cloud, but failed to produce any precipitation. On the following Wednesday, with a clear sky, ten balloons, a hundred and seventy-five shells, and five thousand pounds of roselite were exploded, and the sky remained clear. On the following night the remaining stock of explosives were fired off, regardless of consequences, to get rid of them.

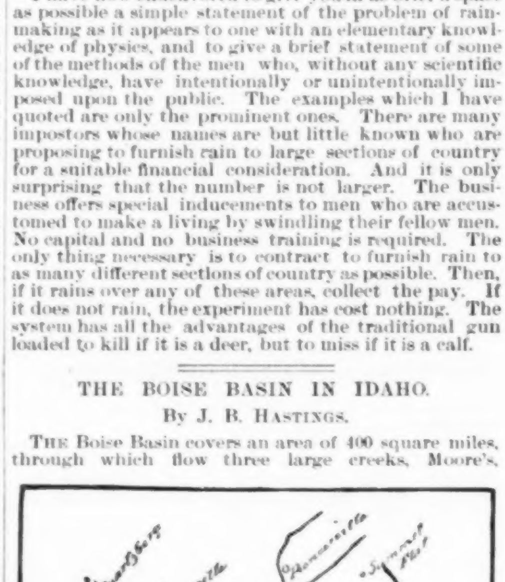
At the time of this national *fiasco*, another patented plan of rainmaking was published, and it was reported that Senator Farwell liked it even better than the concussion plan. It proposes to send up liquefied carbonic acid and to set it free in the portion of air from which it is desired to precipitate the rain. The carbonic acid in vaporizing and expanding must take heat from the surrounding air sufficient to set its molecules vibrating in the gaseous form. Unquestionably we have here the proper kind of an agent for producing rain. The only question to be considered is one of finance. Prof. Macfarlane estimates that one pound of carbonic acid in taking the gaseous form at 72° F. would take up enough heat to change sixty-eight pounds of water by one degree Centigrade. To cool the cubic mile of air formerly considered sufficient to make a rainfall of a quarter of an inch would accordingly take four hundred and six million pounds of carbonic acid. This could probably be purchased in quantities of this magnitude at one dollar a pound, making the expense of a rainfall of a quarter of an inch, not counting anything but the carbonic acid, about six hundred thousand dollars per acre. This would make artificial climate even more expensive than the genuine California article.

I have now endeavored to give you in as brief a space as possible a simple statement of the problem of rainmaking as it appears to one with an elementary knowledge of physics, and to give a brief statement of some of the methods of the men who, without any scientific knowledge, have intentionally or unintentionally imposed upon the public. The examples which I have quoted are only the prominent ones. There are many impostors whose names are but little known who are proposing to furnish rain to large sections of country for a suitable financial consideration. And it is only surprising that the number is not larger. The business offers special inducements to men who are accustomed to make a living by swindling their fellow men. No capital and no business training is required. The only thing necessary is to contract to furnish rain to as many different sections of country as possible. Then, if it rains over any of these areas, collect the pay. If it does not rain, the experiment has cost nothing. The system has all the advantages of the traditional gun loaded to kill if it is a deer, but to miss if it is a calf.

THE BOISE BASIN IN IDAHO.

By J. B. Hastings.

The Boise Basin covers an area of 400 square miles, through which flow three large creeks, Moore's,



SKETCH MAP OF BOISE BASIN, IDAHO.

Grimes and Granite, and many tributaries, and along these are the auriferous gravels. The placers of the district were formerly famous; they yielded in six years after their first opening, from 1864 to 1870, over $40,000,000 in gold. The deposits were not distributed over the whole country in an anomalous manner, as is sometimes conceived, but as elsewhere, along the stream beds and bars connected therewith. The accompanying sketch map gives a general outline of the region. That the gold in the gravel was derived from the veins, and that again from a source deeper than the inclosing granite, is shown by the absence of gold from gulches which do not tap any lodes. Were the gold distributed through the granites in sufficient quantity to allow its concentration in the vein fissures as we now see it, there would also be found deposits in gulches through granitic areas only, the erosion having been great. The country rock of the whole basin and beyond it is light gray, typical biotite granite, with few accessory minerals, and usually deemed part of the Idaho Rocky Mountain archean area; while not differing to any extent mineralogically through the district, it does so in hardness. Probably the freedom with which it disintegrates about Idaho City and elsewhere, forming low rounded hills and flat broad gulches, has suggested the name, "Basin."

The placer deposits on Grimes and Granite creeks are ordinarily distributed stream and glacial debris,

while Idaho City is situated in a former lake bed. Two miles below the town an isolated mass of fine conglomerate or coarse sandstone of unknown age rests on the granite. Moore's Creek cuts through this bed, and two large slides of the conglomerate in the past have dammed the creek and made a lake lasting for sufficient time to allow the accumulation of large bodies of granitic sand in the still water. On the shore of this lake, stream and glacial debris lies on top of the sand, which is hence called "false bedrock;" above Idaho City, Moore's Creek and Bull Run have cut through these gravels, the false bedrock and the true granite bedrock, and formed rich placers about the town by reconcentration. The fact of there being two lakes is proved by silicified trees standing on these gravels in the present soil, and a second granitic sand in some places on the gravel resting on the older sands. The slide of conglomerate forming this second lake broke away from the granite; the contact may be seen below the Warm Springs, one mile back from the present creek and 800 feet above it. The granite scarp, 90 feet high, stands perpendicularly for hundreds of feet; at its base and over the slope to the creek bed is a mass of broken conglomerate fragments ranging from a few feet to a score in diameter. The old channel under the slide has been opened; it is about on the level of the present creek. Whether there is gold beneath the false bedrock resolves itself into the query as to the respective age of the formation of the mineral veins and the older lake. A thorough examination of all the false and true bedrock contacts exposed might solve the problem. A shaft has been sunk 100 feet in the false bedrock at Idaho City; it is a compacted agglomerate of quartz, feldspar and mica grains, a little clay and carbonaceous material.

An eruption of post-tertiary basalt took place at some period on Grimes Creek, flowed down to Moore's Creek junction, backed up that creek for a mile and a half and continued down stream to the Boise River. The basalt filled the channel 150 feet deep and from rim to rim. There has been little erosion at the surface of the flow, but Moore's Creek has cut a perpendicular channel 75 feet below the old one, or so it is claimed by placer miners, the basaltic talus completely covering the slopes preventing observation. The top of the basalt is so far below Idaho City that it could not have acted a part in the lake period about that town. All the "come-at-able" ground has been worked, and the future of Boise Basin placers lies in the hands of a few companies who have secured the more inaccessible deposits and the natural water supply; these will be worked profitably for a score of years. In the early days, when claims were small and water scarce, a heavy percentage of the gold was undoubtedly lost, probably one-third, leaving in these old tailings a large amount, which could all be reworked with a proper system of elevators and flumes. There are reservoir sites in the mountains, but so far no attempt has been made at the proper utilization of water. The main vein fissure and source of the placer gold runs from Quartzberg for 15 miles east, and can be traced nearly the whole distance. This fissure is usually a belt of broken country some 60 miles in width, not a soft, brecciated material, but composed of large, irregularly shaped masses ranging in structure from what may properly be called horses to an impregnation by a network of small veins, but all within the fissure, the hanging and foot walls of which are tolerably well defined. The fissure often follows the course of pre-existent porphyrytic dikes, andesitic usually. The inclosed porphyry and sometimes the fissured dike, in common with the granite masses within the lode, are traversed by fractures and small seams of quartz, and in immediate vicinity of an ore shoot are found sufficiently enriched to be mined as ore. The ore shoots are quite short, from 30 to 100 feet in length, very rich and apparently continuous in depth; the rich streaks follow the channels left for the ascending ore solutions and may lie for a distance on the foot wall and suddenly jump into the middle of the vein or to the hanging wall, or spread out into a number of thin sheets, through the vein filling, making low grade ore. The narrow seams of quartz may assay \$3,000 per ton, and the rock as mined and milled not average over \$10. The reason for these shoots is perplexing here, as elsewhere, where the whole length of vein, rich and poor, was deposited contemporaneously from like cause and effect, and where the barren and gold-bearing quartz is similar in appearance, and also where there is no apparent reason for any favorable reaction of the inclosing walls as a precipitant upon the solutions. The gold occurs free and associated with iron pyrites, largely susceptible to amalgamation; no attempt has been made to work the pyrite, except during the past year in the introduction of a cyanide plant at the Gold Hill mine. A small amount of antimony and an occasional trace of lead are also found. Some ten of the quartz lodes were worked in the sixties, yielding \$1,000,000. Extravagance and bad mine management wrecked them all, and they lie to-day caved and full of water. Only one, the Gold Hill, has operated since the first excitement; it has been worked almost steadily for 25 years. That the mines must be opened by shafts has prevented prospectors from doing much on them since extraction of the rich surface ores.—Engineering and Mining Journal.

IMPURITIES IN SNOW.

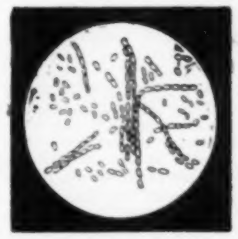
ANOTHER example is given of the incorrectness of the idea that an excellent substitute for distilled water is to be found in melted snow. In a lecture on the "Chemistry of Cleaning," delivered by Professor Vivian Lewes before the Royal Institution, he described the result of this process as applied to snow from the roof of an orchid house at Chelsea. The solid impurities were as follows:

	Per cent.
Carbon	39·0
Hydrocarbons	12·3
Organic bases	1·2
Sulphuric acid	4·33
Hydrochloric acid	1·33
Ammonia	1·37
Metallic iron and magnetic oxide	2·63
Other mineral matter, chiefly silica and ferric oxide	31·24

But the futility of utilizing melting snow in the endeavor to obtain pure water is not the only lesson to be learned from this experiment. Every one knows that an object exposed to the air, with its surface in any position—vertical, slanting or horizontal—and facing either the ceiling or the floor, will gather dust or become coated with a dirt deposit from atmospheric particles. When we see what these particles, such as are brought into the snow, are, the wonder is, says the British Journal, not that photographs printed in silver should ever fade, but that they should be able to resist fading when a coat of sulphuric and hydrochloric acids, nicely arranged for close contact by an absorbing agent, is continually being applied to and received upon them.

ACID FERMENTATION IN TANNING LIQUORS.

THESE investigations were made with an extract of pine bark (30 grms. of bark per liter). It was found that the production of acid in such an extract is due



to the growth of an organized ferment, which was cultivated and isolated. The fermentation follows the usual course, gradually waxing and waning. A detailed account of the experiments conducted for determining what constituent of the bark is converted into the acid, the nature of the gases evolved and the influence of temperature and light, is given. The following conclusions are drawn:

(1) The formation of acid in a pine bark liquor is due to a fermentation.

(2) The ferment is a bacterium, which may be termed bacillus corticalis; it is not identical with the bacillus lacti, although it ferments milk sugar and glucose, with the production of a soluble acid and of the same gases which it evolves from pine bark liquor.

The microscopical appearance of the bacillus is shown in the figure (amplification not stated).

(3) The constituents of the bark which are fermented are the saccharine substances (Fehling reducing compounds). The fermentation does not occur in pure tannin solution.

(4) The products of the fermentation are a soluble acid and a mixture of much hydrogen and little carbon dioxide. In one experiment the evolved gas contained 94·6 per cent. of hydrogen and 5·4 per cent. of carbon dioxide; no estimation of the carbon dioxide remaining in solution is quoted.

(5) The fermentation will not take place below 6° C.; the most favorable temperature is between 30° and 40° C.

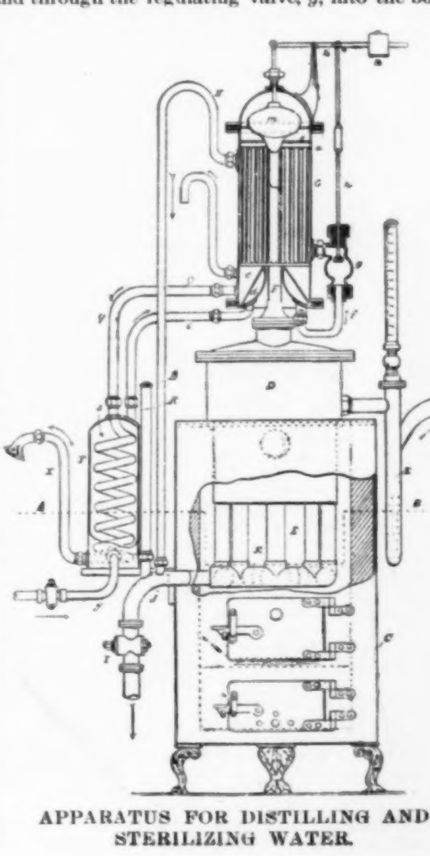
(6) Light hastens the fermentation.

A similar fermentation was observed in extracts of oak bark, mimosa and sumac, but not in extracts of quebracho and myrabolans.—F. H. Haenlein, Dingler's Polyt. J., 1894.

APPARATUS FOR DISTILLING AND STERILIZING WATER.

By J. NAGEL, Chemnitz, Saxony.

THE water to be treated enters the closed vessel, T, by the pipe, Y, rising by the pipe, Z, into the space, *d*, under the condensing vessel, G, thence by the pipe, *f*, and through the regulating valve, *g*, into the body of



APPARATUS FOR DISTILLING AND STERILIZING WATER.

the said vessel, G, where, after filling the space surrounding the vertical tubes, N, it finds an outlet near the upper end through the bent tube, H. On descending the latter tube (the cock, *r*, being closed) the water reaches the system of heating tubes, R and E, over the firegrate, and the evaporating vessel, D, which it fills to a height indicated by the gauge glass, K. The vessel, D, is surmounted by the steam tube, F, closed at its upper end by the weighted and balanced valve, *m*, which passes through the perforated plate, *e*, and is in connection with the regulating valve, *g*, through a lever and the rod, *h*. On steam being raised to the desired pressure in the vessel, D, it escapes through the valve, *m*, into the dome-shaped space above, and, passing through the tubes, N, is condensed. The resulting water drops into the conical space, *c*, thence passing through the tube, Q, and the cooled coil, S, finally issues, as distilled water, by the pipe, X. The small bent tube, U, acts as a safety valve against undue steam pressure, while the siphon pipe, L, which can be provided with the thermometer shown, enables a portion of the heated water to flow off direct from the vessel, D, after having been sterilized by boiling. The automatic feeding of the apparatus is regulated by the action of the valve, *m*, which on rising through increased steam pressure, simultaneously opens the feed valve, *g*, thereby admitting fresh water, which in its turn has a cooling effect upon the contents of the vessel, D, tending to reduce the steam pressure and to close the steam valve. The tap, *r*, is provided for the purpose of emptying the apparatus.

MANUFACTURE OF COCAINE.*

ALFRED EINHORN and RICHARD WILLSTÄTTER.

THE manufacture of cocaine from the alkaloids accompanying it is technically effected, as has been known for some years, by boiling these alkaloids with concentrated hydrochloric acid, which results in decomposing them into ecgonine and acids belonging to the aromatic series; from the ecgonine the cocaine can readily be obtained by synthetic reactions. This partial synthesis of cocaine is accomplished by one of two methods: 1. The ecgonine is *benzoylated, i. e.*, converted into benzoyl-ecgonine, and this is then *esterized* with methyl-alcohol yielding *cocaine*, the methyl-ether of benzoyl-ecgonine, or more simply benzoyl-methyl-ecgonine. 2. The ecgonine can first be esterized, forming methyl-ecgonine, and this can then be benzoylated.

The alkaloids occurring with cocaine, which have been obtained in a pure condition, and which are derivatives of ecgonine, like isatropylcocaine and cinnamylcocaine, have been proved to be derivatives of methyl-ecgonine and the aromatic acids; it was therefore reasonable to suppose that other alkaloids which have not as yet been isolated would also be found to be derivatives of methyl-ecgonine. With this supposition the problem was imposed of preparing methyl-ecgonine directly in the decomposition of these alkaloids, thereby simplifying the technical manufacture of cocaine from this source.

We have found that this problem is easily solved if the alkaloids be boiled for several hours with sulphuric or hydrochloric acid in the presence of methyl-alcohol; this gives conditions under which methyl-ecgonine is not decomposed, but, on the contrary, tends to be easily produced or formed.

Fifty gm. of the cocaine accompanying alkaloids are boiled on a water-bath for three to four hours (using, of course, a reflux condenser) with 300 gm. methyl-alcohol and 100 gm. pure sulphuric acid; after distilling off the alcohol, the sirupy residue is poured into water (the quantity of this, however, must not be excessive), the aromatic acids, but more especially their esters (methyl-esters), which are precipitated are removed, and the acid solution extracted with chloroform; the acid solution is next saturated with potassium carbonate, and the methyl-ecgonine, which separates as an oily layer, extracted with chloroform.

The same results are obtained when dry hydrochloric acid gas is passed into the methyl-alcohol solution of the alkaloids until the solution, which at first becomes warm, again becomes cold; the solution is then boiled for two hours, using a reflux condenser, and the methyl-ecgonine isolated as just described. The ester, methyl-ecgonine, was obtained in almost theoretical quantity; it was purified by conversion into the hydrochlorate, which, recrystallized from alcohol, had the melting point, as stated by Einhorn and Klein, of 212° C. Distilled in a vacuum, methyl-ecgonine gives in the main a distillate free from decomposition products, boiling at 177° C. under a pressure of 15 mm.

If in the process as described ethyl-alcohol be substituted for the methyl-alcohol, there results ethyl-ecgonine instead of methyl-ecgonine. A similar observation was made by Einhorn and Konek de Norwall when in heating dextro-methyl-ecgonine in an ethyl-alcoholic solution of ammonia in a sealed tube to 100° C., they found that there was produced dextro-ethyl-ecgonine. We can add that cocaine can be quantitatively converted into its higher homologue, cocethyline, by boiling for two hours an ethyl-alcohol solution of cocaine which has been saturated with hydrochloric acid gas. —*Am. Jour. Pharm.*

THE COMPOSITION OF ATMOSPHERES WHICH EXTINGUISH FLAME.†

By FRANK CLOWES, D.Sc. Lond., Prof. of Chemistry, University College, Nottingham.

A STUDY of the experiments which have been made to determine the composition of atmospheres which act extinctively upon flame shows that in many cases the atmosphere under examination was in contact with water. The solvent action of water on the carbon dioxide present seems in such cases likely to disturb the composition of the mixture. In other cases only the proportion of oxygen in the extinctive atmosphere was noted, and the nature of the diluent gas or gases was not taken into consideration. Experiments were also limited to the flames of a few combustible substances, or where a wider range of different flames

* Translated from the *Berichte der deutschen chemischen Gesellschaft*, 27, 1523, by Frank X. Moerk.

† A paper read before the Royal Society.

Combustible substance burnt.	Extinctive proportion of carbon dioxide added to air.			Extinctive proportion of nitrogen added to air.		
	Percentage added.	Percentage composition of mixture.		Percentage added.	Percentage composition of mixture.	
		O	: (N+CO₂)		O	: N
Alcohol, absolute	14	18·1	81·9	21	16·6	83·4
Alcohol, methylated	13	18·3	81·7	18	17·2	82·8
Paraffin, ordinary lamp oil	15	17·9	82·1	23	16·2	83·8
Colza oil with equal volume of petroleum	16	17·6	82·4	22	16·4	83·6
Candle	14	18·1	81·9	22	16·4	83·6
Hydrogen	58	8·8	91·2	70	6·3	93·7
Carbon monoxide	24	16·0	84·0	28	15·1	84·9
Methane	10	18·9	81·1	17	17·4	82·6
Ethylene	26	15·5	84·8	37	13·2	86·8
Coal gas	33	14·1	85·9	46	11·3	88·7

was tried, the results reported were only of an approximate and relative nature.

The experimental work, the results of which are summarized in this communication, was undertaken in order to supplement the deficiencies referred to above, with the view of drawing further generalizations, and of furnishing support to those already drawn from previous experiments.

The mixtures of air with the extinctive gas were made in a glass cylinder, which was closed by a ground glass plate.

A measured quantity of water, equal in volume to the percentage of extinctive gas to be mixed with the air, was first poured into the glass cylinder. The cylinder was then closed by the plate and inverted in a vessel of water. A light xylonite ball of known volume was then passed up, and the extinctive gas was introduced in sufficient quantity to fill the cylinder. The cylinder was then closed and its contents were mixed by the movement of the ball.

In order to test the accuracy with which any desired mixture of gases could be prepared by this method, two mixtures of air with carbon dioxide were submitted to analysis. They furnished respectively 9·8 instead of 10 per cent., and 69·7 instead of 70 per cent. of carbon dioxide.

The experimental flames used were 0·75 in. in height and were gradually lowered into the cylinder, the top of which was finally covered by the plate. The gases were burnt from a platinum jet 1 mm. in diameter.

The gaseous mixture was considered to be in extinctive proportions if the flame was extinguished during its downward passage, or immediately upon attaining its lowest position in the cylinder. The mixture was considered to contain the *minimum necessary quantity* of extinctive gas, when another mixture containing 1 per cent. less of the extinctive gas allowed the flame to continue burning in it for a few seconds only.

The limiting differences between the results of repeated trials corresponded to 1 per cent. of the extinctive gas in the air.

This minimum necessary percentage of extinctive gas is recorded above in tabulated form.

It was considered necessary to take the immediate extinction of the flame as the criterion of extinctive power, since the composition of the atmosphere was rapidly affected by the combustion of the flame.

As a matter of convenience, the flames were, in all cases, set to a height of 0·75 in. But a series of experiments was undertaken with the same flame of varying size, in order to ascertain if the proportion of extinctive gas necessary to extinguish the flame varied with the size of the flame.

The results of these experiments with flames of hydrogen and alcohol, varying from 0·4 in. to 1·5 in. in height, show that the varying dimensions of the flame, within the wide limits included in the trials, are without influence on the proportion of carbon dioxide in the air necessary to produce extinction.

The carbon dioxide employed for the experiments was prepared in the usual way by the action of diluted hydrochloric acid upon marble. It was washed with water, and was proved to be practically free from air.

The nitrogen was prepared by heating an aqueous solution containing potassium nitrite, ammonium chloride, and potassium dichromate. An analysis of the resulting gas proved that it contained 99·7 per cent. of nitrogen.

Results Obtained by the Experiments.

In the accompanying table the number entered is the average of numerous closely concordant experimental results. The percentage volume of nitrogen in air is taken as 21.

Characteristic differences were observed between the behavior of wick-fed flames and that of gas-fed flames when they were introduced into an atmosphere which extinguished them. The wick-fed flames gradually diminished in size until they vanished. The gas-fed flames, on the other hand, gradually increased in size, becoming pale and apparently lower in temperature, and then suddenly expired. The extinction of the flame is apparently due in both cases to the lowering of its temperature. This primary cause, however, seems to operate directly in the case of the gas-fed flame, while in the case of the wick-fed flame it operates by gradually reducing the amount of combustible gas and vapor produced, and leads ultimately to the flame dying from lack of combustible material. The large expansion of the gas-fed flame is evidently due to an attempt to obtain the necessary supply of oxygen in the diluted atmosphere by increasing its own surface.

The following deductions seem to be warranted by the results arrived at in these experiments:

1. That the extinction of a flame is not determined only by the *proportion* which the inert gas bears to the oxygen of the atmosphere into which it is introduced, but that the *nature* of the inert gas present also influences the result.
2. That carbon dioxide uniformly exerts a more powerful extinctive effect upon flame than nitrogen does.
3. That there is a remarkable uniformity in the proportions of inert gas which must be mingled with air in order to just extinguish wick-fed flames.
4. That this uniformity does not apply to the flames of combustible gases burnt from a jet.
5. That the flames of gases burnt from a jet show no simple relation, as regards the proportion of oxygen present in the extinctive atmosphere, to the relative proportions of oxygen required for their complete combustion.

With regard to the superior extinctive power of carbon dioxide over that of nitrogen, it has been stated that the greater the density of an inert gas which is introduced into air, the less will be the quantity which suffices to arrest combustion. Waldie suggests that this is due to the cooling effect produced upon the flame by the rapidity of diffusion of its heated products increasing as the surrounding atmosphere increases in density. But it is probable that carbon dioxide also surpasses nitrogen in its extinctive effect upon flame in virtue of its higher specific heat, and because of its slower movement owing to its high molecular weight and density. When the heavy gas is mingled with the air, it adds to the density of the mixture, and renders the atmosphere more sluggish in its movement toward the flame to supply the necessary oxygen.

It has been anticipated that in the presence of the hydrogen flame, and possibly of other flames, carbon dioxide would have suffered partial deoxidation, as it is well known to do in the presence of burning magnesium vapor. No such action appeared to occur, else the above relation between the extinctive powers of carbon dioxide and nitrogen could not well exist.

The cause of the comparative uniformity of the proportion of extinctive gas required for wick-fed flames has been already hinted at. The flames are starved of combustible nutriment by the lowering of the temperature of the flame. This cause seems to operate with strikingly similar results upon the different solid and liquid combustibles.

The cause of the want of conformity to theoretical considerations in the case of the gaseous flames fed from jets is not at once apparent.

It is of practical interest to note that the introduction of a minimum of 15 per cent. of carbon dioxide into air is necessary to cause it to extinguish ordinary wick-fed flames, the oxygen being reduced by this admixture from the normal proportion of 21 per cent. to 18 per cent. For the extinction of a coal gas flame, however, the addition of 33 per cent. of carbon dioxide is necessary, the oxygen being thus reduced to 14 per cent. The hydrogen flame has far greater vitality, requiring the admixture of 58 per cent. of carbon dioxide with air, and the consequent reduction of the oxygen to 8·8 per cent., before it suffers extinction. This fact is of great importance, since it shows that the hydrogen flame in the composite miner's safety lamp (Roy. Soc. Proc., lii., p. 486) may be used as an auxiliary to prevent the loss of flame when the lamp is being carried through mine air containing large proportions of carbon dioxide.

I have to thank one of my senior students, Martin E. Feilmann, B.Sc., for conducting much of the experimental work involved in this research.

(April 28, 1894.—Recent experiments seem to prove that a rabbit can breathe with impunity for at least an hour air containing 25 per cent. of admixed carbon dioxide (J. R. Wilson, *American Journal of Pharmacy*, l., No. 12). If this is the case, the extinction of an ordinary flame does not prove the surrounding atmosphere to be irrespirable. The introduction of 15 per cent. of this gas extinguishes a flame, while the air seems to be still respirable, even after it has been mingled with an additional 10 per cent. of carbon dioxide.—F. C.)

TAR SOAP.

THE special cleansing action of tar soap for certain rough toilet purposes is probably as well defined as is that of gall soap for removing spots from cloth, and in this respect there may be little to choose as between pine tar and birch tar, both possessing this cleansing property; coal tar being considered out of date nowadays for soap making purposes.

But as regards the disinfecting power of such soap, there is—according to recent investigation—a great difference in the use of pine tar and of birch tar. Nencki reports in the Pharm. Ztschr. Russl. that, from experiments he made, he finds that pine tar (from Pinus sylvestris) has double the disinfecting power of birch tar, owing to the presence of larger proportions of kresol, guaiacol, etc., while in birch tar compounds of the paraffine series are more abundant.

For the purpose of distinguishing beech tar and pine tar, Hirschsohn recommends the following process: At 20° C. (68° F.), beech tar has a specific gravity of 0·925-0·945; while pine (fir) tar, at the same temperature, is 1·02 to 1·05, the one floating in water, while the other will sink if entirely freed of air. Beech tar, agitated with 10 volumes of water, abandons none of its coloring matter, though the water, while remaining perfectly colorless, acquires a markedly acid reaction. The addition of perchloride of iron to the water produces a green color reaction. If 2 drops of anilin and 4 drops of hydrochloric acid be added to 5 c. cm. of the water, a yellow color reaction results. If 1 volume of beech tar be agitated with 20 volumes of petroleum ether and filtered, a clear, brownish yellow liquid is obtained, which does not become green when agitated with a diluted solution of copper acetate.

The aqueous extract of fir tar is, on the contrary, colored a marked yellow, is of acid reaction, but becomes red on the addition of Fe Cl₃ (instead of green). Treated with anilin and H Cl, the color passes to red. The petroleum solution, agitated with copper, becomes green. Finally, when pine (fir) tar and alcohol are agitated together, the former takes up no color. If there is any muddiness, or even cloudiness, you may be certain that the tar is contaminated with beech tar, kerosene products, coal tar, etc.

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